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ABSTRACT

A project was conducted to develop two evaluation designs for computer-assisted instructional (CAI) packages used in the remediation of basic skills in Job Training Partnership Act (JTPA) programs. Information was gathered from a literature review identifying principal factors and issues germane to the evaluation design; site visits, interviews, and observations; and structured interviews with expert panels, consultants, service providers, and vendors. The taxonomy developed by the project is a system of classifying CAI packages based on the needs of the JTPA population and the degree of complexity and quality of the technology employed in the CAI packages used by JTPA programs in the remediation of basic skills. The taxonomy requires consideration of types of CAI packages and quality measures. Two evaluation designs have evolved from the rationale and taxonomy: (1) a large-scale, longitudinal design equal to approximately six professional person years of effort; and (2) a small-scale, survey-type evaluation effort. Both evaluation designs are structured to provide information about the effectiveness and efficiency of CAI packages used in basic skills remediation in JTPA programs. (Includes 64 references and lists of vendors, experts panel, consultants, and programs interviewed.) (KC)

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A Project to Design an Evaluation of the Appropriateness and Effectiveness of Computer-Assisted Instructional Packages Used in the Remediation of Basic Skills

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Executive Summary

The National Commission for Employment Policy (NCEP) contracted with the Institute for the Study of Adult Literacy at Penn State to develop two evaluation designs for computer-assisted instructional packages used in the remediation of basic skills in the Job Training and Partnership Act (JTPA) programs. Basic skills include reading, computation, communication, problem solving, and analysis.

Background

The use of computer-assisted instructional (CAI) packages for the remediation of basic skills in employment training programs is increasing rapidly. The "basic skills crisis," the national need to increase basic skills learning efficiency, and the federal response of focusing employment and training resources on the assessment and remediation of basic skills have contributed to the proliferation of use of CAI packages in employment training programs. Consequently, employment and training professionals are concerned about the effectiveness and efficiency of CAI packages are requesting assistance in obtaining reliable information about the utility of CAI packages in the remediation of basic skills and in identifying effective procedures for selecting appropriate and effective educational software.

This project addressed the needs articulated by the employment and training professionals with the production of five important products: a rationale for utilization of CAI packages with JTPA clients; a taxonomy based on client characteristics and technology features; a survey-type form for evaluating CAI packages; and two evaluation designs, a large-scale, longitudinal study and a small-scale survey.

Project Methodology

The rationale for the use of CAI packages in JTPA programs was based upon client characteristics and salient features of computer technology. Taxonomical features were culled from a review of relevant literature identifying principal factors and issues germane to the evaluation designs, a series of site visits permitting interviews with project personnel and observations of operating programs, and structured interviews with members of expert panels, consultants, service providers, and vendors. Written and verbal responses to the rationale and taxonomy from more than 35 respondents were incorporated into the evaluation designs.

Panels of representatives from the U.S. Departments of Labor and Education, the AFL-CIO, business and industry, minority groups, and Adult Literacy and Technology (ALT) consultants, were formed to review and critique project materials as they developed. A total of 15 panelists reviewed materials and made contributions during the developmental stage of the evaluation designs.

Five JTPA sites, four located in Pennsylvania and one in New Jersey were visited by project staff. These sites, representing a range of program types, provided important data about the actual utilization of computer-assisted packages with JTPA clients. Additional service providers were surveyed by telephone.

CAI packages published by 12 different vendors were provided for review and examination. Additionally, a site visit was made to a Delaware software company to pilot test the evaluation form on CAI packages designed for JTPA clients.

Taxonomy of CAI Package Features

The taxonomy developed by this project is a system of classifying CAI packages based on the needs of the JTPA population and the degree of complexity and quality of the technology employed in the CAI packages used by JTPA programs in the remediation of basic skills. The taxonomy requires consideration of three categorical factors useful in describing CAI packages:

1.0 Types of CAI Packages

1.1 Purpose of the Package

1.2 Context Orientation of the Package

1.3 Instructional level(s) of the Materials

It also requires consideration of three major factors affecting quality of CAI packages intended to be used in JTPA programs:

2.0 Quality Measures

2.1 Curriculum Features

2.2 Software Design Features

2.3 Implementation Features

The taxonomy includes a description of various aspects of each of these six factors and reflects the concern of educators and trainers for giving increased attention to the curriculum and related learning activities provided through the CAI packages. The curriculum is a major factor in stimulating and guiding student learning. It is important, therefore, that CAI packages be evaluated not only on their technical merits in terms of software design and implementation options but also on their curriculum design.

An evaluation instrument has been designed to establish values for each of the factors in the taxonomy. The instrument provides an objective means of categorizing CAI packages by producing standardized numeric measures of quality for each of the features identified by the taxonomy.

The evaluation instrument, together with the taxonomy, will serve the important role in the evaluation designs of operationalizing, establishing values for, several of the important variables related to the CAI packages used in JTPA programs. They will also provide a means of obtaining a uniform, objective rating for CAI packages intended for use in JTPA programs that may have utility outside of the planned evaluation process.

Evaluation Designs

Two evaluation designs have evolved from the rationale and taxonomy: (a) a large-scale, longitudinal design equal to approximately six professional person years of effort; (b) a small-scale, survey type evaluation effort. Both evaluation designs are structured to provide information about the effectiveness and efficiency of computer-assisted instructional (CAI) packages used in the remediation of basic skills in JTPA programs. The primary purpose is to obtain information about the differential effects of CAI packages and their cost-effectiveness rather than to evaluate the participating programs per se.

The criterion variables used in both are measures of JTPA participant performance on standardized measures of achievement in the basic skills. The effectiveness of the program in delivering instruction to participants is assessed by pre-test and a post-test measures of their performances on standardized measures of achievement in the basic skills. The primary question to be addressed is the extent to which the use of CAI packages contribute to increased JTPA participant performance in basic skills compared with the increase provided by traditional methods of instruction, those not using CAI packages in the remediation of basic skills.

The large-scale evaluation design has an expected duration of two years and involves a variety of methods employed to assess the effectiveness and efficiency of CAI packages used in the remediation of basic skills in job training programs. It evaluates and contrasts two treatment modes: computer-assisted instruction against traditional instruction, each in their natural program settings. The design uses existing program participants, instructors, teaching methods, curriculum materials, software, and equipment and attempts to monitor and measure the differential effects of the treatment modes.

The small-scale design followed principally the same analytic framework but relies on surveys for data collection. Both designs use an evaluation form developed in the project to assess the quality of CAI packages used in the remediation of basic skills.

Introduction

The use of computer-assisted instructional (CAI) packages for the remediation of basic skills in employment training programs is increasing rapidly. The "basic skills crisis," the national need to increase basic skills learning efficiency, and the federal response of focusing employment and training resources on the assessment and remediation of basic skills have contributed to the proliferation CAI package usage in employment training programs. Consequently, employment and training professionals are concerned about the effectiveness and efficiency of CAI packages and are requesting assistance in obtaining reliable information about the utility of CAI packages in the remediation of basic skills. The information is needed in making decisions involving the use or expanded use of CAI packages in their programs and in identifying effective procedures for selecting appropriate and effective educational software.

The National Commission for Employment Policy (NCEP) contracted with the Institute for the Study of Adult Literacy at Penn State to develop two evaluation designs for investigating the effect of computer-assisted instructional packages used in the remediation of basic skills in the Job Training and Partnership Act (JTPA) programs. Basic skills include reading, computation, communication, problem solving, and analysis.

A number of tasks were included in the scope of work assigned to the evaluation design project, including a survey of current knowledge about the key elements involved in the evaluation: training programs, participants, staff, CAI packages, and current research.

A significant task was to develop a taxonomy of features found in CAI packages based on the needs of the target population and on the degree of complexity and quality of the technology employed. The taxonomy provided the rationale for an instrument to evaluate CAI packages. The two evaluation designs which evolved present alternative approaches to investigate CAI effectiveness at different levels of effort: (a) a large, longitudinal study equal to approximately six professional person years and (b) a small-scale, survey type project.

Chapter 1

Survey of Current Knowledge

The project undertook a survey of current knowledge relative to the characteristics of JTPA programs and participants and computer-assisted instruction. The survey was accomplished with a review of relevant literature, a series of site visits allowing interviews with project personnel and observations of operating programs, and input from members of expert panels, service providers, and vendors.

The intent of the literature review was to obtain and present a clear understanding of the principal factors and issues related to the prospective evaluation designs, rather than to produce a comprehensive review of the literature on any single topic.

Five JTPA sites visited by project staff, four located in Pennsylvania and one in New Jersey, represented a range of program types. The site visits provided important data about the actual utilization of computer-assisted packages. The interviews and observations at the sites yielded descriptive information about the characteristics of classrooms, participants, and instructors.

Valuable information was provided by an expert panel composed of representatives from various organizations nationwide. Dr. Eunice N. Askov, Director of the Institute for the Study of Adult Literacy at Penn State, extended invitations to participate to representatives of the U. S. Departments of Education and Labor, AFL-CIO, business and industry, and minority groups. Panelists and Adult Literacy and Technology (ALT) consultants were each sent a survey questionnaire, a project abstract, and drafts of preliminary materials developed for use in subsequent evaluation designs. The representatives were asked to respond in writing or by telephone.

Contacts were made with service providers nationwide through their respective service delivery areas (SDAs) or upon recommendations from members of the expert panel and vendors. Chosen because of geographic location, demographic representation, CAI utilization, and accessability, service providers were contacted by telephone and interviewed, guided by the survey questionnaire. Those wishing to participate further were sent additional materials to review and critique.

Time constraints posed problems with mail turn-around and telephone contacts, thus limiting the number of respondents. A listing of all participants is provided in the appendix.

As anticipated, the information gathered was invaluable in the development of the two evaluation designs. The responses from the expert panel, ALT consultants, service providers and vendors, incorporated in this report and in the evaluation designs, provided input on four key issues:

- Characteristics of JTPA programs
- Characteristics of JTPA participants
- CAI use in JTPA programs
- Cost-effectiveness of CAI packages

Characteristics of Job Training and Partnership Act Programs

The JTPA operates under the block grant concept of funding state and local programs. Primary responsibility for administering the federally funded programs rests with the states. States assume the oversight and administrative functions while local communities undertake actual delivery of program services to participants. Funds are distributed to state governors according to a formula specified in the legislation based on unemployment and poverty figures. The governors reallocate 78 percent of the money by similar formula to SDAs, approximately 600 nationally, within their states. SDAs subsequently reallocate funds to local projects.

JTPA operates on forward-funding intended to reduce uncertainties and problems associated with late appropriations. Program planners should therefore know in advance funding levels available for the year. Further, the states are guaranteed to receive no less than 90 percent of their preceding fiscal year's allocation from the block grant program. These funding procedures are very important for programs considering the purchase of computer equipment and implementation of a computer-assisted instructional component. The overall funding level for JTPA has been stable at approximately $3.5 billion per year since it began in October, 1983 (NCEP, 1987, pp. 5-8).

An examination of the characteristics of JTPA programs involves a categorization by title. Each title addresses different objectives for servicing the needs of distinct target populations.

Title II: Adult and Youth Programs

Eligibility for Title II-A programs is broadly defined by the legislation; participants need only be "economically disadvantaged" to receive services. A 1985 demographic report described the 752,900 people served as (NCEP, 1987, p. 53):

- 92% economically disadvantaged
- 53% female
- 45% minority
- 42% 21 years or younger
- 40% public assistance recipients

Program services are divided into five categories:

1. Classroom training (CT): basic education, occupational skills training, or a combination of the two
2. On-the-job training (OJT): skills training in a specific occupation in an actual work setting
3. Job Search Assistance (JSA): support with locating, applying for, or obtaining jobs.
4. Work Experience (WE): part-time or short-term subsidized employment designed to assist participants in entering/re-entering the labor market.
5. Other services: those not included within the other categories.

The performance of JTPA programs is monitored with national performance standards established by the Secretary of Labor. The performance standards reflect the "return on investment" model in which investment in the programs is assessed against increased participant employment and earnings and decreased welfare dependency. In 1986, the average cost-per-placement standard was $4,374 for adults and $3,711 for youth (NCEP, 1987, p. 12)

Title II-B provides for summer programs serving disadvantaged youth aged 14 to 21. Funds may be used for remedial and basic education, as well as WE, OJT, or any job-related activities which prepare youth for work. The 1987 cost was approximately $1,000 per participant (NCEP, 1987, p. 82).

Title III: Employment and Training Assistance for Dislocated Workers

Dislocated workers are individuals whose jobs have been terminated because of plant closure, unacceptable performance, or other reason for which they are unlikely to return, or who are long-term unemployed with limited prospects for re-employment in previous occupations. Nearly 170,000 participants were served from the beginning of the program in October,1983, through March, 1985 (NCEP, 1987, p. 95) and 95,600 in program year 1985 (p. 219).

Participant characteristics reported by the U. S. Department of Labor and General Accounting Office (GAO) in 1987 were (NCEP, 1987, p. 93):

- 60% male
- 69% white
- 88% between the ages of 22-44
- 55% high school graduates
- 60% from the manufacturing sector

- 57% receiving unemployment insurance

Program services provide basic skills training, CT, OJT, and job placement assistance.

Older, less educated dislocated workers are reportedly less likely to participate in the program, possibly because of apprehensions about remedial or classroom situations. Potential clients in this category have difficulty meeting minimum qualifications for training programs and are thus more likely to be victims of the "creaming" effect in which only clients with the best prospects for success are selected for services.

Title IV: Federally Administered Programs

The major program under this title is the Job Corps. Native Americans, migrant and seasonal farm workers, and veterans are also entitled to receive services under separate programs.

The purpose of Job Corps is to assist economically disadvantaged young men and women, aged 14 to 22, who can benefit from an intensive residential program. The duration of the total service program is usually six months and includes remedial education, skills training, and work experience. Participants are provided subsistence, clothing, health care, and recreation. Currently, 107 Job Corps programs service 100,000 persons per year at an estimated cost of $15,000 per person.

Characteristics of JTPA Participants

JTPA participants can be categorized as high school dropouts, low-achieving high school graduates, displaced homemakers, dislocated workers, and English-as-a-Second-Language (ESL) clients. Obviously, the needs and learning styles of such a diverse group will vary greatly.

Needs

A high percentage of adults with learning disabilities have been recognized by teachers in Adult Basic Education (ABE) programs, according to Ross and Smith (1988). Travis (1979) suggested that the incidence may be as high as 80 percent, a sharp contrast to the learning disabled (LD) population, reportedly less than 5 percent, in public schools. ABE teachers in the Ross-Smith study concluded:

> All groups acknowledge that poor writing and spelling skills were problems frequently faced by learning disabled students, but they also believed that LD adults frequently find ways to compensate for their learning problems. When asked whether they felt that skill deficits in adults with learning disabilities were caused by poor study habits, they disagreed. Respondents also disagreed that support services for the learning disabled tend to delay development of self-reliance and independence, but did not believe that any program for learning disabled students would be sufficient to eliminate learning problems. (p. 25)

Mikulecky, Ehlinger and Meenan (1987) predicted only a small and shrinking number of available jobs in which workers could function with low level literacy skills. Newly created jobs require reading and writing skills considerably higher than the basic skills level. The demand is for "broad" technicians rather than "high" technicians (Mikulecky et al., 1987). Therefore, adults in JTPA programs will have few occupational choices if they cannot meet the high literacy requirements of the work place (Mikulecky et al., 1987).

Learning Styles

No specific research on the learning styles of JTPA participants has been documented. Because, the profiles of the typical drop-out and low achiever, constituents highly represented within the JTPA population, indicate difficulty with processing information, the following research on learning styles can be justifiably applied to JTPA participants in general.

Learning style has been defined by Bottroff-Hawes (1988, p. 40) as:

> a person's modality strength (auditory, visual, or kinesthetic-tactual). combined with the brain hemispheric preference for organizing and processing information (right/global; left/sequential; mixed).

The growing body of knowledge about learning styles and the cerebral processing of information mandates a change in the traditional methods of teaching. Bottroff-Hawes maintains that schools are unresponsive to half of the school population because of the proliferation of traditional instructional activities best suited for left-brain dominant, auditory students.

Dixon (1982) emphasized the necessity of considering learning styles of participants with other factors when designing a training program. Because the dominant learning style dictates the way an individual processes and gathers information, Dixon maintained, accommodating learning style differences can improve participant learning and reduce training time (Dixon, 1981). Likewise, Dunn and Bruno (1985) demonstrated in school situations that accommodating student learning styles improved performance.

No single learning style is superior to any other, Martin (1986) concluded; most students use all learning styles to some degree. However, because most students use their dominant learning style at least 90 percent of the time (Keefe, 1979), Martin emphasized that teacher understanding of learning styles can provide students with optimum learning experiences.

Respondent Comments

The information received from the panelists, consultants, and service providers addressed the needs and learning styles of JTPA participants. The responses may be divided into the categories of the needs for youth, adults, adult work force entrants, displaced workers, and non-English speaking adults.

Youth

- Basic skills including reading, math, computer literacy skills, pre-employment skills, personal development, hygiene, and nutrition

- General Equivalency Diploma (GED) and occupational information and training
- Development of basic skills so that a sense of accomplishment is provided for students
- Supportive services for disabilities
- Screening for developmental disabilities
- More individualized instruction and coaching
- Hands-on-learning experiences
- Counselors for goal-setting, motivation, and building self-esteem
- Assistance with making connections between training and work situations
- More variety in activities and shorter segments than adults to counteract hyperactivity
- Assistance with problems associated with single-parent families, rebelliousness, peer pressure, and offenders
- More exposure to diverse settings, situations, and opinions
- Financial assistance
- Child care
- Transportation

Adult

- Upgrading reading and math skills
- Day care and other support services, such as transportation and personal development skills
- Entry-level job skills
- Age-appropriate materials
- Assistance with accommodating for severe learning difficulties which many have
- Pre-training sessions for use of JTPA programs
- GED preparation and examination
- Awareness of choices and possibilities
- Improving concentration and focusing
- Survival and coping skills
- Building self-esteem and overcoming feelings of failure and inadequacy
- Assurance in new learning situations

Adult Work Force Entrants

- Processing and organizing information "to do" and "to access"
- Basic skills
- Employment training
- Knowledge of personal strengths and weaknesses as related to different job requirements
- Assistance with changing negative attitudes and reacting to adverse situations
- Improving work habits

- Accessing telephone and transportation services

Displaced Workers

- Assistance with transferring work experience from one job to another
- More relevance and immediacy of application of skills
- Improving job skills and job search techniques
- Upgrading skills in math and reading
- Working through the anger and depression of job loss
- Building self-esteem

Non-English Speaking Adults

- English language training
- Assessment to determine other learning difficulties
- Remedial education in math and reading
- Visual, auditory, and kinesthetic aids
- Job skills training and job search technique
- Child-care
- Transportation

Computer Assisted Instructional Packages for JTPA Programs

The literature review identified salient features for creating a taxonomy of CAI evaluation criteria to be used in the evaluation designs. The criteria were developed from numerous studies of CAI usage in training and educational programs.

Use of Computer-Assisted Instruction in Training Programs

CAI packages continue to attract attention among training professionals (Kamouri, 1984). Declining costs of computers and technical advances in software and hardware design have increased the possibility for individualizing and improving the training process for people at different levels of ability (Kamouri). As illiteracy approaches crisis proportions, the need exists for educational programs capable of increasing the probability of learner mastery and corresponding more closely with the world of work (Caldwell & Hedl, 1984).

General

Clients in a successful project evaluated by Caldwell and Hedl (1984, p. 77):

1. Indicated that the computer-assisted instruction made reading

easier, particularly because the computer offered greater amounts of reinforcement and instruction on an individual basis than the teacher could in a typical classroom situation

2. Expressed a preference for learning via the computer rather than in a class where their learning deficiencies were easily recognized by teachers, and more significantly, by other learners
3. Favorably changed their opinions about reading and working with numbers
4. Demonstrated an increased interest and self-motivation in regard to learning new things
5. Expressed more self-confidence about success in testing situations

Simulations

A study by Bruhn, Grabenhofer, and Cather (1984) of CAI simulation in industry indicated savings in instructor and student time and improved instruction with self-paced and reality-based learning. The system maintained student records, eliminated need for instructor observation, and reduced need for individual feedback. This type of instruction eased peer pressure and increased access to varied and individualized practice.

"Supplemented" CAI

Kamouri (1984) examined "supplemented" CAI training systems by applying the same standards and measurements. Supplemented CAI programs use adjunct modes, such as highly interactive graphics, simulators, and applied exercises, that allow trainees to apply concepts and to perfect skills within simulated environments. The majority of research incorporating supplemented CAI has been supported by the military because of their intense training needs.

Displaced Workers

The use of CAI is increasing with low literate adult learners. A study by the Institute for the Study of Adult Literacy at Penn State supports the utilization of CAI with displaced workers (Bixler and Askov, 1988). Functionally illiterate workers are unemployed for longer periods of time, are less likely to qualify for job training programs, and less likely to participate in traditional basic skills programs. Traditional literacy instruction utilizes a tutor to deliver instruction. Because computers in the work place are common, Bixler and Askov emphasize the importance of the acquisition of both basic skills and computer literacy skills to ensure competitiveness in the marketplace. Further, they stress teaching skills in a functional context. Prompt recognition of the relevance of learning is particularly powerful with this population. "By using the computer to teach basic skills, the student is also learning computer skills as well" (p. 16).

CAI versus Traditional

Students in Askov, Maclay, and Bixler's 1987 CAI study also demonstrated greater learning increases within a given period of time, in comparison to traditional methods. Clarke (1983) cites other studies with similar results. These researchers caution that longitudinal studies should be conducted in order to confirm their findings.

CETA

Studies, however, in the use of CAI in CETA programs have reported somewhat negative findings. In two basic skills programs investigated by Caldwell and Hedl (1984), the CAI program was not significantly more effective than the regular program. Both programs were plagued by irregular attendance, lack of commitment to program goals, and failure to complete significant portions of the curricula. Caldwell and Hedl (1984) concluded that appropriate incentives for acquiring basic skills are necessary for success in both the teaching and learning process.

The researchers identified conditions essential for success for any JTPA basic skills project (p. 84):

1. Learners must want to acquire skills.
2. Learners must have an accurate perception of what they are learning.
3. Learners must take responsibility for a task and accept the consequences of success or failure in performing it.

In addition, the study demonstrated the importance of a full-time teacher who is committed to improving instructional performance. Computer-assisted materials must integrate job skills, life skills, and basic skills to make the learning important and relevant to life.

Caldwell and Hedl argued against unqualified acceptance of the negative findings in their study. They advocated computer-assisted instruction as being particularly useful for teaching basic skills to adults who have experienced learning difficulties.

- A multi-sensory approach to learning can be highly motivating.
- The curriculum is individualized and feedback immediate. As a student progresses, confidence grows.
- Programs are flexible and adaptable to a wide variety of needs.

Use of Computer-Assisted Instruction in Schools

Because many JTPA programs focus on the needs of youth, knowledge of the use of CAI materials in schools and their comparative strengths and weaknesses will enhance the present study.

Cooperative Learning

Johnson, Johnson, and Stanne (1986) compared the relative efficacy among cooperative, competitive, and individualistic learning situations in promoting (a) achievement, (b) oral participation by male and female students, (c) equal status between male and female students, and (d) positive attitudes toward computers. Seventy-four eighth grade students were randomly assigned to conditions stratifying for sex and ability. The study found that computer-assisted cooperative learning promoted the following:

- Higher quantity and quality of daily achievement
- Accuracy of recognition of factual information studied and ability to apply facts in test questions requiring higher-level reasoning and problem solving
- More success in complex problem-solving tasks involving mapping and navigation
- Greater success in operating a computer program.

In addition, students in the cooperative and competitive groups scored higher on achievement tests than the students in the individualistic group. Further, the cooperative computer groups promoted more student-to-student interaction and equal status for all group members. Noteworthy is past research indicating female avoidance of computers and under-representation in computer studies.

Individualization

That learners vary in the amount of time needed to master a lesson, depending upon their aptitudes, experience, and motivation, is common knowledge. CAI can vary from full adaptation to no adaptation for the learner. Studies by Ross (1984), Merrill (1980), and Tenneyson et al. (1984) indicated the potential of individualizing the amount of instruction for increasing effective learning.

Yang (1987), studying the use of CAI with individualized instruction, distinguished between "individual" and "individualized" instruction. The former treats one student at a time, while the latter describes the tailoring of instruction to fit the individual's unique learning needs. This distinction is relevant to the needs of JTPA youth participants whose learning styles require "individualized" instruction. Individualized instruction, suggest Bergan and Dunn (1976), is characterized by:

- A broad array of educational objectives and extensive alternative content
- A variety of instructional procedures, settings, and contexts
- An extensive cross-indexing of curricular objectives, materials, methods, and learning contexts
- An extensive data base regarding the individual student's interests, abilities, aspirations, optimum learning styles, long-range goals, and ambitions
- An extensive cumulative record on each student regarding his past academic accomplishments and academic records
- A file of information regarding constraints imposed by parental preferences and state and local requirements and restrictions imposed virtue of supply,

logistics, and administrative considerations.

In addition, Merrill (1984) and Tennyson, Christensen, and Park (1984) described five parameters through which individualized instruction progresses:

- Instructional amount
- Display time
- Instructional sequence
- Personal attention
- Internal learning activities.

Pacing

Each learner requires a different amount of time for processing and storing information (Yang, 1987). Individualized learning speed is important for both efficiency and effectiveness of learning. Two types of pacing to consider in learning speed are external pacing and self-pacing. Results from studies are mixed.

Slow learners learn better through slow-paced instruction rather than self-paced instruction. Self-pacing can lead to learner procrastination. More research is needed in this area before appropriate choices can be made for various learners.

Time Savings

CAI packages release teachers from the need to be constantly motivating students to master various materials. (Mevarech & Rich, 1985). The benefit for teachers in this regard is more time for other instructional activities (Dalton & Hannafin, 1984).

Sequence

Instructional sequence is important so the structure matches student knowledge. Ideally, adult learners should have control over choosing content. Concern over instructional sequence exists, however, because learners are not always familiar enough with the subject content to know how best to control its sequence (Yang, 1987), thereby creating gaps and deficits in essential information.

Reinforcement

One of the perennial virtues of CAI has been its positive reinforcement for the learner. Yang (1987) advocates, along with researchers Ross (1984) and Gaynor (1981), the importance of varying the feedback according to specific learner needs.

Slow learners need immediate feedback, while high level learners require end-of-session feedback.

Self-esteem

Many young JTPA participants have not been successful in school and are, therefore, considered to be at-risk. Research on the effect of CAI programs upon student self-esteem may provide helpful information in dealing with this troubled target group.

In 1985, Mevarech and Rich found that students who participated in CAI math programs rated themselves significantly higher on self-concept in arithmetic achievement than students exposed to the same material in a traditional instructional setting. Brown (1986) and Dalton and Hannafin (1984) found mastery of subject content and development of computer literacy to be potential sources of positive affective development. In addition, they found that external support, especially in the form of peer group reinforcement, appeared to contribute to a positive attitude. Clement (1981) observed that non-judgmental, neutral, and consistent reinforcement offered by the computer is an optimal reward situation.

Finally, all the researchers mentioned above emphasized the learner's freedom from embarrassment, disapproval, and diminished status which can occur in classroom situations when a student's failure to perform correctly is public knowledge. With CAI packages, students are allowed to learn through trial and error in private at their own pace.

Robertson, Ladewig, Strickland, and Boschung (1987) developed a study to evaluate the effects of CAI packages on student global self-esteem, an area previously unaddressed empirically. Over 1,000 students taking a home economics course participated in the study, a two-group pre-test and post-test experimental design. A supplementary CAI package was used as the experimental treatment. Students in the experimental group scored significantly higher on self-esteem than did students in the control group. The researchers emphasized the findings that the CAI packages had potential for enhancing students' self-esteem.

Behavior Disorders

Recent research has extolled the virtues of CAI packages for students with behavior disorders, an attribute relevant to JTPA programs because of its emphasis on youth who have been unsuccessful in conventional school settings.

Students with behavior disorders (BD) students may be described as lacking motivation toward academic and social success in school and success in school-related tasks (Manion, 1986). These students can also be characterized as being unable to concentrate on tasks for a sustained period of time. Behavior disorders cause cumulative academic problems for the students, as well as classroom management and control problems for teachers of these students (Manion, 1986).

The connection between CAI packages and the educational needs of BD students is based on the contention that CAI can control the learning environment both quantitatively and qualitatively (Bowman, 1982; Chaffin, Maxwell, & Thompson, 1982). CAI can stimulate depressed interest in learning, increase persistence, attention, and personal involvement in task performance. Further, it purportedly promotes self-esteem and self-discipline (Manion, 1986).

Needs

Hannafin, Dalton, and Hooper (1987) outlined certain computer-related needs which are important for JTPA programs serving youth 14-21 years of age.

1. **A comprehensive computer-driven curriculum.** Although the type, quality, and quantity of educational software has increased dramatically in the last ten years, this collection of software could be termed a "patchwork" curriculum because it differs so radically from one vendor to another.

2. **Greater computer friendliness.** Although computers have advanced significantly in this area, there is still room for improvement.

3. **Experiences and opportunities across economic and gender lines.** Wealthy school districts are able to provide CAI simply because they can afford it. Females tend to have more limited exposure to computers because of the perception that computers are largely tools used in math and science courses in which females have traditionally been under-represented.

Components of Effective CAI Instruction

It is imperative that computer training systems be based upon theoretical foundations of learning (Kamouri, 1984). Fortunately, current research in cognitive psychology has significantly influenced their design. In recent years, the movement to integrate training and instructional thinking with the advances of cognitive science has gained momentum. Kamouri defines certain components of an effective instructional system that can be used for analysis.

Responsiveness

Responsiveness reflects the degree of learner-computer interaction and the adaptability of the program to differences in skill or knowledge level across the learner population. The greater the inclusion of these factors in the system design, the more responsive the system is, and the better its training potential. Kamouri cites numerous studies that lend credence to the idea that superior and rapid adult learning is associated with more personalized, self-paced, and self-directed computerized instruction.

Flexibility

Flexibility or user control, another related system component, is the ability to personally vary the sequence of information presentation. This includes the individual user's determining the route through lessons, whether to use branching options, and the amount of time spent on different training tasks. Superior learning is reportedly found in highly flexible systems where the trainee has control over his/her own learning (McCann, 1981; Lehey, 1981).

Multiple Modes

The use of multiple modes in an instructional program may also contribute to effective instruction. Graphic displays, simulations and problem solving exercises can enhance the acquisition of concepts and facilitate the development of a more detailed model of the knowledge domain (McCann, 1981). Graphics is one of the more actively researched components of instruction. Gagne (1981) determined graphics to be effective as perceptual organizers in focusing attention to key features and important aspects of an information display. McCann (1981) cautioned that differences exist between individuals of higher mental ability and individuals of lower mental ability. Higher mental ability individuals benefit from presentations that are perceptually complex, informationally laden, of fixed pace, and with multi-channel motion pictorial forms. The opposite is true of lower mental ability individuals. Therefore, CAI programmers should limit the animation and displays in presentations for slow learners.

Measures of CAI Effectiveness

An analysis of computer-assisted training research by Kamouri (1984) produced a number of significant findings. Various computer-assisted instructional systems were rated in cost efficiency, training time savings, managerial satisfaction, positive trainee attitudes, and measures of objective performance on training related tasks.

Training Time

CAI research was examined for evidence of the measures identified by Kamouri. Training time savings was reported as a measure of effectiveness, accounted for by the self-pacing and individual scheduling flexibility features. Studies of electronic technicians and job related technical information (Schwartz and Haskell, 1966; Schwartz and Long, 1967) report significant savings of 10 percent and 15 percent respectively by computer instructed groups versus self-study groups and in centrally located computer-trained versus remotely trained.

Very rapid success by a group whose CAI packages included options for review, recap, quiz, and rote learning was reported by Seidel, Wagner, Rosenblatt, Hillelsohn, and Stelzer (1978). The group was not empirically compared to a non-CAI group, however. Krupp (1972) evaluated Honeywell Corporation's program to upgrade the skills of technical employees and facilitate the acquisition of new job related information. The interactive tutorial CAI system, responsive and adaptive to user input and flexible in ability to set the lesson branching networks according to user needs, averaged seven hours, in comparison to the 24 to 30 hour range for traditional instructional.

Negative findings were reported by Wallis (1964) in a Naval Technical Training System using a linear programmed instruction program with electrical mechanics. No significant decrease in training time compared with the traditional training system was indicated.

In a follow-up study integrating the programmed instruction course with class tutorial sessions and prescribed text notes, Wallis (1964) reported less training time than that for both the original programmed instruction system and traditionally trained groups. The results indicate that CAI programs incorporating user control and flexibility are more time efficient.

In addition, programs that reflect more variety in design yield greater time savings than those that do not.

Satisfaction

Another criterion for measurement is positive attitudes and satisfaction. The majority of studies report positive attitudes from trainees for the computer-based training system and satisfaction on the part of the supervisors or training managers (Kamouri, 1984). Not all studies were empirically tested against traditional methods, however, and, therefore did not control for the novelty of the training approach.

Swissair and British Airways were highly satisfied with their new CAI system used in training clerks to use new procedures for operation (Stammers and Patrick, 1977). Different organizations and government agencies have reported satisfaction with CAI because of its convenience, money savings, and reported favorable employee attitudes (Buck, 1982; Leblanc, Bristica, & Evers, 1978).

Significantly better attitudes among CAI group participants than the traditionally trained group participants were reported by Schwartz and Long (1967) and Wallis (1964).

In contrast, Wallis (1964) reported that trainees engaged in a programmed instruction course for electrical mechanics were dissatisfied with the program. After the program was integrated with more variety, more favorable attitudes were noted. Technical trainees at Honeywell using the CAI tutorial disliked the inability to query the system, CRT glare, and slow response time. The same participants, however, reported satisfaction with the program's thoroughness, ability to handle wrong answers, and rapid progress through materials.

In examining the measure of attitudes and satisfaction, studies generally showed positive results with the introduction of CAI packages (Trollip, 1979; Cain, 1981; Conkright, 1982; Weitzman, Fineberg, Gade, and Compton,1979). The attitudes of trainees toward using the CAI simulators improved, after initial resistance, with exposure to the system (Weitzel et al., 1979).

Negative attitudes toward a flight trainer in a CAI program were reported by Crawford and Crawford (1984).

CAI versus Traditional

Schwartz and Haskell (1966) found no difference between CAI and traditional self study groups in technical information training.

Another CAI area explored was learner performance measures. Wallis (1964) found that technicians in an unmodified programmed instruction course had lower exam grades than those in traditional training groups. Schwartz and Haskell (1966) and Schwartz and Long (1967) reported achievement on technical information post-tests comparable for CAI groups and self-study groups. Results for centrally integrated programmed instruction courses were superior to those for basic programmed instruction and other traditional methods (Wallis, 1964).

Computer-assisted flight trainees showed superior performance over traditionally trained pilots, attaining criterion performance significantly faster than comparison groups (Trollip, 1979; Crawford & Crawford, 1978) and making fewer critical errors (Trollip, 1979). Mitzel (1974) claimed that the CAI inservice teacher education program produced better results than traditional course performance. CAI course exams were 24 percent higher than exams for classroom courses.

Summary

In conclusion, Kamouri (1984) maintains that computers have had an important overall affect on training programs. Because they are meeting many training needs, industries are increasingly adapting computer systems to train their employees. It is evident from the research that knowledge acquisition is being facilitated. The generalizability of the training can be seen in various computer-assisted training programs. The use of simulators and supplemented CAI techniques seem to be the most favorable programs with respect to their design and effectiveness in promoting learning. These systems incorporate more flexibility into the human-computer interaction.

The effects of multiple modes or instructional supplements, more user control, personalized feedback, and increased adaptivity to user characteristics were favorable to developing skill proficiency, and in some cases, training generalizability.

However, there is a lack of empirical research on the independent effects of these program components and objective performance measures in comparison to traditional training methods (Kamouri, 1984).

Respondent Comments

The panel members provided information about how CAI packages are used in various JTPA programs, how well computer-assisted instruction serves program objectives, and teacher/instructor qualifications. Cited programs varied in CAI package utilization. Some programs had extensive computer centers with 10-15 computers available for client use while others were limited to fewer than five computers. Most of the programs utilize "stand-alone" systems because of the expense of networks. The majority of network systems are housed in programs that have purchased U. S. Basics or Control Data services.

The following are respondent comments about their experiences with CAI packages:

In the Adult Learning Center, Control Data's PLATO (implemented on a local area network) is used to provide Basic Skills Reading and Math remediation and GED preparation. The scope and sequence of the PLATO curriculum meets the objectives of the Adult Learning Center in a most favorable manner. In the past year, 76 percent of the Center's students met their employability development objectives. The PLATO lab instructors are certified teachers who have received approximately 5 days of training by Control Data before operating the lab. [The lab] has been operating for 4 years and the instructors are considered national experts on the Local PLATO Delivery System. Two out of three of the PLATO Lab instructors had no previous computer experience.

CAI packages are currently being used for drill and practice and instruction. We feel that they do a fair job in serving program objectives. Our instructors would be rated as fairly well-qualified to use computer-assisted instructional packages.

CAI packages are used as an additional tool to supplement training. They serve program objectives quite well. They seem to be very effective. Our instructors seem well-qualified in the use of CAI.

We use CAI for as much instruction and drill as possible. They are being used to review and give practice in all areas of instruction. They serve the objectives very well; students who would not do flashcards will do the drills on the computer. Our JTPA instructors are qualified teachers and are very comfortable with all of our software. They have received computer and software training. They are always eager to learn something new.

CAI packages are specifically selected to meet skills identified by the state department of education in math and reading. They serve program objectives extremely well. Our students show gains in math and reading of two to four normal curve equivalent scores (NCEs), which is very good. Teachers in our lab are certified public school teachers, who may not have had computer experience. They participate in a week long training session.

CAI is used as supplemental instruction with students spending 33 percent of their time on the computer. The computer instruction is primarily drill and practice. We feel that CAI serves our program objectives very well. Our students like working with computers and they find their learning more exciting. Our instructors do not have to be certified teachers, although an education background helps. What we have found to be more important than education is a willingness to learn new things.

Our clients spend 40 percent of their time on computer instruction. We use an assortment of software and a computer management system. We have found that CAI serves our objectives very well. We do not feel our teachers need to be computer experts.

CAI packages are used concurrently with other instructional methods. A particular package is selected on the basis of strengthening a diagnosed reading weakness as determined by reading specialist and students together. A program objective is to make the program participants independent in the pursuits of goals. CAI helps them do this.

Interactive CAI packages with an auditory component are excellent with ESL clients because the computer provides an added feature of patience.

Networked learning systems are more useful and effective than stand-alone systems. They remove the need to work with hundreds of diskettes. A learning system that does not operate as a franchise allows the user to adapt the system to local needs and priorities.

We are moving from stand-alones to networked systems which are easier to handle. Training for stand-alone systems required five days at the outset, with three to six days follow-up per year. Much of that was tied to an awkward, complex record-keeping system which was required under a franchise operation. Staff had to be more computer literate for that system and were often bogged down with malfunctioning system software and lack of knowledgeable technical staff at the corporate headquarters.

CAI is used for instruction with our clients spending 50 percent of their time in computer instruction. We see CAI as the wave of the future for the at-risk population. It is less threatening, more comfortable for the client to use, and the client gets immediate rewards. We like CAI a lot. Our teachers are used as coaches and do no classroom instruction.

CAI is used for remediation in math and reading, as well as GED preparation. Computers are not going to solve all problems and should be viewed as only an aid to the teacher. Teachers do not have to be computer experts, but they do need to be able to react to students.

JTPA Program Site Visits

Purpose

In order to obtain key information about the actual use of CAI packages in JTPA programs for the remediation of basic skills, site visits were made to five selected JTPA programs in Pennsylvania and New Jersey. A sixth visit was made to a software developer. Specifically, qualitative information was sought on characteristics of participants, objectives of the programs, current CAI package usage, cost-effectiveness, and how well CAI packages serve program objectives. Further, JTPA program staff were asked to critique the CAI taxonomy and proposed criteria for CAI package evaluation developed by this project. The qualitative information gained from the site visits supplemented the information obtained from the literature. The visits provided more depth and detail to an understanding of the variety of current CAI usage and provided specific information that should influence the development of designs for evaluating the effect of CAI packages.

Format of Site Visits

Structured interviews were conducted with the person in charge of the instructional components of the JTPA programs, using the same survey questionnaire distributed to the expert panelists and consultants.

The five sites, selected with assistance from SDA representatives listed in the JTPA Service Delivery Area Directory, 1988-89 Edition, were chosen on the basis of geography, demographics, type of CAI packages in use, and type of computer system used. The programs varied from "high tech" to what one instructor called "no tech." One of the "high tech" programs was chosen because it used a complete CAI curriculum, including a management system operating on a sophisticated local area network. The staff there was highly skilled in use of computers. Other sites reflected varying degrees of competency with computer and CAI usage.

Contact with site personnel to complete arrangements for the site visits was made by telephone. The project purpose, questionnaire, and taxonomy and rationale were discussed with the site staff.

Site Visit Results

A synopsis of the data collected from the site visits are noted below with a description of each program.

Site Visit One

The site, located in a large urban area in one of the poorer sections of the city, serves primarily Black clients with multiple needs, including low self-esteem and problems associated with single-parent families and exposure to drugs and alcohol. The community center housing the program offers a wide variety of programs for all age groups. Enrichment and remedial programs are offered for school age children and ABE programs for adults. The center participates in a state-run experimental program for teen-age mothers. The center has used CAI for at least a year.

Private corporations in the city provide most of the funding for the various programs. A small portion is provided through JTPA, Title II. The corporations view support as an investment in the development and training of prospective employees.

Private donations paid for the installation costs of a Control Data Local PLATO Delivery System with 15 PLATO workstations and 6 stand-alone Apple IIe's. The hardware for the PLATO system cost approximately $100,000.

Teachers and other center staff participated in the Control Data training program as part of the installation package. The center pays $5,000 a year for a maintenance contract. The center director and assistant are knowledgeable about computers and have strong backgrounds in math and science. It is noteworthy that the staff was very enthusiastic about the PLATO program and comfortable with the technology. They viewed computers as a way to better meet the needs of their clients.

Local companies have been impressed with the academic progress of students participating in the center programs. Student progress has been documented through the computer management system. The system documents the progress of participants and quantifies the results. The center director maintains that the documentation has helped in getting more private funding because the results were objectively measured.

The director is adept at operating Control Data's Curriculum Management Delivery System and is able to program individualized curricula for students and to track their progress. The stand- alone Apple IIe computers, used for supplemental work with school children and word processing for adults, are not used for instruction because of the excessive time required for monitoring, given the number of participants.

The center focuses on enrichment activities for a core group of school age children. For adults, the focus is on remediation of basic skills and acquisition of job skills. For teenage mothers the concern is breaking the welfare cycle by providing academic and social support. Leadership and moral development are a key part of the program for all age groups.

The following are important observations made at the site:

- No matter how sophisticated a computer system is, teachers still remain a critical component of the instructional program.

- Orientation sections within CAI packages are essential in assisting clients with no prior computer exposure through the process in a non-threatening manner.

- All Adult Basic Education CAI packages should have feedback systems which allow for interaction between the instructor and peers. Although computers may accommodate the skill and academic needs of participants, they cannot deal with personal needs. Supplemental activities providing constant reinforcement and reassurance and acknowledging successes are needed.

- The center instructors did not identify any significant differences in the learning needs and styles of different clients. Youth and adults did not differ greatly except by age. Displaced workers, accustomed to a standard of living which they try to maintain with fewer resources, tend to experience more frustration. They are also more prone to quit before completing programs if a financial opportunity, even if short-term, arose.

- Because the expense of computer hardware is cost-effective only when used constantly, the center maintains daytime and evening hours six days per week and services, without cost, a nearby elementary school.

Site Visit Two

The site, located in a medium sized city with average unemployment problems, is a comprehensive JTPA program with basic education, job search, summer youth, and occupational skills programs. In operation for more than 10 years, the program is staffed by three instructors, two of whom are new. The director has been with the program from its beginning and has basic computer knowledge. The two teachers are inexperienced with computer usage.

The ABE program has used CAI packages to teach remedial skills and prepare students for the GED examination for more than a year. Initial funding for a variety of computer equipment and CAI packages came from various sources. IBM's PALS program is used to teach reading and operates on four IBM stand-alone computers. The total cost was $75,000. Apple IIe's use "patchwork" software. A Control Data computer is not used because of limited software and lack of instructor skills.

A major problem has been finding affordable software to meet the needs of the adult population. Several purchases of expensive software were unsatisfactory; either the software was too difficult for the staff to operate or it did not perform as expected. The center now previews material before purchasing.

The clients served have diverse training objectives. A typical day may require ESL, basic skills instruction, and preparation for the GED exams. Needs within categories differ also. For instance, some ESL clients may need only language instruction while others also need basic skills instructions.

The program director offered several interesting observations:

- Much of the ABE software is not adequate for instruction because it provides mainly drill and practice.

- CAI should be used in combination with other instructional approaches.

- Both hardware and software must be made easier to use and more functional as instructional tools. Many instructors are not adequately trained to use computers; some have negative attitudes against computers as instructional tools. Currently, utilizing the computers is difficult because of low instructor computer illiteracy.

Site Visit Three

Located in center-city, the site's JTPA funds are channeled through an intermediate unit (an administrative liaison between the state and local education agencies). Clients, aged 14 to 86, vary in characteristics and instructional needs. Clients often have low self-esteem, are young single-parents with several children with no transportation, driver's license, telephone, nor marketable skills. Many have learning disabilities and have experienced little or no success in traditional school settings. Teachers in the program are skilled in providing positive learning experiences for such clients.

An enthusiastic staff has used CAI packages for at least a year and a half. The adult program purchased Apple IIe computers with carry-over funds from a previous year. The teachers are competent users of computers and software and develop some of their own CAI materials. The staff estimates that students use computers four to five hours per person per week, some to a greater extent than others.

Because of limited resources, purchases are carefully considered. Despite these precautions, some CAI packages have proven not to meet their expectations. For example, an ESL program with a management system records student scores in a manner that has no practical application.

Pertinent comments and observations from the program staff follow:

- CAI packages should be easy to load, easy to access, incorporate a management system, and present materials in small increments.

- Content of CAI packages should be appropriate for the age and experience levels of the targeted learner. The material should be neither offensive nor condescending to the learner. Youth do not identify with materials which present life situations from the perspective of middle class, successful adults.
- Some CAI packages advertised for adult learners appear as mere "facelifts," new titles covering existing child-oriented content.
- Computer instruction is useful in dealing with a wide variety of clients who are functioning at different skill levels. Students receive immediate feedback from the computer and cannot advance without mastery of the material.
- Software, claiming editing features, should contain clear, concise instructions for organizing and tailoring lessons for the specific needs of individual learners.

Site Visit Four

This program, located in a small college town, provides services to dropouts and adults. JTPA funds are channeled through an intermediate unit. Program objectives are GED training and remediation of basic skills in preparation for other training programs. The small program is operated by one instructor. The teacher finds the mixed age groups of students beneficial for interaction. The older students help motivate the younger students.

One stand-alone Apple IIe is available for participant use with a limited amount of software. CAI plays a very minor role; time is not scheduled for student usage. The primary purpose is exposure to the basic routines of loading software, using menus, and printing documents.

The teacher has limited computer knowledge and indicated little interest in developing further computer skills. A former biology teacher in public schools, she is accustomed to teaching with limited equipment and instructional aids and does not feel inhibited by a shortage of equipment. She indicates a strong preference for "traditional paper and pencil" method of instruction and identifies her program as "no tech."

Site Visit Five

This ABE/GED program is housed in a vocational school and receives JTPA, Title II funding from the local private industry council (PIC). The funds are supplemental, sufficient only for purchase of materials. The primary funding source is the Department of Education. The SDA makes referrals to the program and may provide the participants some financial assistance.

Clients, aged 16 to 64, are primarily female. All meet JTPA income criteria and have relatively low incomes. Academic abilities vary. Some are high school graduates; others have not been successful in school. Self-esteem tends to be low. The client population is mobile. Attendance is sporadic.

The objectives of the program depend upon the needs of the clients. Some receive GED training. Others enroll to improve basic skills in preparation for college, business school, or better jobs. A special program for displaced homemakers is provided through the intermediate unit. There are no time restraints; a participant may take one week or 16 weeks to successfully complete preparation for the GED exam.

The teacher functions as a counselor as well as an instructor, often referring clients to agencies which can help them with specific problems. She has formal training in providing computer instruction. Two Apple IIe's are used primarily for drill and practice, which the staff strongly advocates for student achievement. The program also has access to the vocational school's computer center during the summer.

The staff has developed a software evaluation form. Each CAI package is previewed and evaluated before purchase; problems with purchases are rare.

Site Visit Summary

The five site visits were useful in supplying practical information necessary for the development of the CAI evaluation designs. Program personnel responded candidly to questions. Each of the programs provided a different perspective of computer-assisted instruction. The following is a synopsis of commonalities and pertinent points gleaned from the visits:

- Program staff are concerned with the necessity for ease of software utilization and hardware operation because of the demands upon their time. Packages that are not "user friendly" are ignored.
- The level of computer literacy and confidence among the personnel varies greatly. The majority with major responsibility for CAI implementation have minimal training. Some are apprehensive; others are enthusiastic about the possibilities offered by the technology.
- None of the programs uses CAI exclusively. Teachers are acknowledged as essential components of the instructional process, an opinion affirmed by feedback from the expert panelists. This is not consistent, however, with some of the research on CAI that minimizes the value of interaction between teacher and student. The nature of the JTPA population mandates positive reinforcement and guidance to ensure success during all phases of the instructional process.
- Program personnel do not perceive a wide disparity in learning styles and needs of clients among the Title II, III, and IV programs. Most youth have life experiences similar to adults. Both groups have learning difficulties exacerbated by multiple personal problems.
- Program personnel could not discuss CAI cost-effectiveness using concrete measures.
- Presentation of CAI content must be age-appropriate in order to accommodate the special needs of the JTPA population. Instructors indicate a preference for materials which allow them to customize lesson sequences and content for individual learners. CAI packages designed for skill development without considering the process of learning are considered to be of little worth.
- Most JTPA programs have scarce resources. CAI packages are expected to perform as advertised; otherwise, the choice will be conventional materials that are readily accessible, predictable, and easily assessable.

An Assessment of the Cost-Effectiveness of CAI Packages

Levin and Woo's (1981) study of the cost-effectiveness of drill and practice packages by the Computer Curriculum Corporation (CCC) is considered the first systematic cost examination of CAI. An analysis of CAI cost-effectiveness, Levin and Meister (1986) proposed, should include: description of the number of students, the duration of the instruction, the necessary personnel, facilities, hardware, software, training, and maintenance. A detailed inventory must be completed on each of these areas and a cost determined. CAI hardware and facilities must be allocated over their respective lifetimes.

CAI versus Traditional Methods

Cost comparisons between CAI and conventional instruction have been seldom studied. Buck (1982) reported a $70,000 savings with a system having a seven-year life-cycle. Because of initial high start-up costs, an important factor for cost savings analysis, Kamouri (1984) cautioned against studies that are not longitudinal.

Levin and Meister (1986) contrasted CAI packages with cross-age tutoring and schemes for varying instructional time and reducing class size. Their results showed that CAI packages were more cost-effective than adult tutoring, reducing class size, or altering instructional time. Nevertheless, peer tutoring in mathematics was considerably more effective than CAI. CAI was slightly less effective than peer tutoring in reading.

These investigators concluded that while CAI may be relatively cost-effective, it is not the most cost-effective method in improving reading and math achievement in elementary students. Levin and Meister cautioned against unqualified acceptance of CAI as the most cost-effective method of instruction and recommended that decision-makers consider instructional goals, available resources, and staff proficiency before choosing to implement a CAI package.

A study by Neimiec, Blackwell and Walberg (1986) disputed the results of Meister and Levin (1986), contending that Levin and Meister overestimated the achievement gains of peer tutoring and underestimated those of CAI. Their study found CAI to be twice as effective as peer tutoring.

These conflicting results indicate the difficulty in estimating the cost-effectiveness of CAI. Non-tangible factors such as client motivation and speed of instruction need to be considered. Obviously, further research on cost and performance is needed.

Cost-Effectiveness Analyses

The literature on cost-effectiveness is sometimes unclear because of ambiguous terminology. For example, studies investigating "training" may use variables related to either (a) skills training and instructing of students with CAI packages, e.g., remediation, or (b) the training of instructors to use CAI packages with students, e.g., teacher inservice. Complicating the assessment process is the nesting of (a) costs related to implementation within (b) costs related to instruction. The following outline is presented to clarify the relationship between factors germane to a CAI cost-effectiveness analysis:

INSTRUCTION COSTS
1. Learning time
2. Staff size
3. Materials
4. Implementation and utilization costs
    a. Installation
    b. Maintenance
    c. Hardware
    d. Software
    e. Instructor training
        (1) Time away from job
        (2) Travel expenses
    f. Trainer
        (1) Time
        (2) Travel expenses

Conceptualizing this hierarchy will aid in deciphering the research results which follow.

Instruction Costs

Learning Time

Time savings studies report significant decreases. Reductions by two-thirds have been reported for "Criteria Referenced Instruction" pilot training (Kamouri, 1984) and teacher retraining (Mitzel, 1974).

Materials

Supplemented CAI

Supplemented CAI systems, those adding features like animation, interactive audio, touch screens, light pens, mouses, and adjunct workbooks and video, have yielded savings in cost (Kamouri, 1984), training time (Mitzel, 1974), and instructional staff size (Cain, 1981).

Hardware Costs

Levin and Meister (1986) estimated the costs of the CCC program, including 10 minutes of daily drill and practice for students, at $136 per student in 1978. In 1984, the costs were re-estimated based on current costs, and the program was estimated at $120 per student. A considerable decrease in the cost of computer hardware accounted for the decrease in overall costs for the program. It was estimated that hardware costs decreased from 1/4 to 1/9 of the overall cost of CAI programs between the cost estimates made in 1978 and 1984. Levin and Meister (1986) suggest that almost 90 percent of the cost for CAI programs is associated with personnel, software, training, and other costs. This means that further reductions in hardware costs can only affect a small percentage of overall CAI costs. According to their 1984 estimates, 38 percent of the total costs were for personnel and 21 percent were for curriculum and software.

Software Costs

The numerous types of CAI packages available have created a competitive market for more than 100 vendors. Currently, for general education, there exists a wide variety of software from which to choose.

Pressman and Rosenbloom (1984) cited cost among several factors hampering the development of CAI packages. CAI packages are designed for different purposes and allow for differing amounts of learner interaction. For example, Frenzel (1980) suggests:

1. Testing — the computer presents questions and grades the students answers
2. Drill and Practice — reinforces previous learning by presenting practice problems
3. Tutorial — programmed instruction which permits learning in sequential frames with branching to permit individualized pacing for each student's needs
4. Dialogue — permits an unstructured "conversation" between the student and the computer
5. Simulation — the computer acts as an environment, permitting the student to manipulate parameters and observe the outcome.

In addition to considering the cost of developing software for various purposes, analysis can be conducted along the dimension of cost-effectiveness of CAI versus conventional materials for each purpose, e.g., comparing the cost of testing with CAI versus testing with pencil and paper.

Levin and Meister's CAI cost-effectiveness study (1986) comparing CAI packages with peer tutoring indicated reduced costs of CAI packages and their increased performance outcomes as primary factors driving the use of computers in instruction in schools. The investigators noted that the cost of microcomputers had decreased by 50 percent since 1980 with concurrent growth in the variety of software available.

Implementation and Utilization Costs

Pressman and Rosenbloom (1984) analyzed implementation of CAI packages by investigating hardware, software, user training, installation, and maintenance. A recent study by TURNKEY (1988) cited cost and lack of staff expertise as two major barriers to the implementation of CAI packages.

Installation and Maintenance

Usually, the installation costs for CAI packages and microcomputers are minimal, because most packages are installed by project staff (Pressman & Rosenbloom, 1984). In general, vendors have provided effective installation instructions and technical assistance. Peripherals and accessories, including printers, plotters, disk drives, and monitors are important cost elements. Additional costs may be incurred if extra electrical outlets are required. Costs for appropriate furniture is another consideration.

Hardware maintenance costs have decreased as microcomputers have become more standardized and reliable. The cost of a hardware maintenance contract is usually 15 to 25 percent of the unit price annually (Pressman & Rosenbloom, 1984).

Software maintenance and other costs are complicated by unauthorized use and duplication. Because of piracy problems, software companies try to recoup their costs up front (Pressman & Rosenbloom, 1984). Users need to be aware of the licenses restrictions that apply to their use of the software. Yearly costs of software maintenance have been estimated at 10 to 30 percent of original price of the software (Pressman & Rosenbloom, 1984).

Hardware/Software Compatibility

Over the years, there has been remarkable improvement in the availability, variety, and quality of educational software. Purchasers must consider the problem of compatibility of the software with the hardware.

Training Costs

Training costs are an essential element in an analysis of the cost-effectiveness of CAI packages. This is especially true for small, rural JTPA programs which lack the resources that larger, more urban programs may have. In small, rural programs, limited staff knowledge and expertise restricts the use of CAI packages. Pressman and Rosenbloom (1984) saw this as a crucial issue. They were concerned with effective CAI training. Training costs are high. Manufacturers provide a minimum of support, often at extra cost to the consumer (Frenzel, 1981).

Consumers must consider both time and money in determining costs. Difficulty of learning CAI packages varies with the vendors and the packages. Often, vendors agree to train one or two users. Training of others are at extra costs (Pressman & Rosenbloom, 1984). Large organizations often develop their own training programs to help defray training costs. This may not be an option for small programs. The Minnesota Educational Computing Consortium (MECC) was developed in the public sector in answer to the need for computer training (Pressman & Rosenbloom, 1984).

Training costs should decrease in the future due to greater microcomputer use, increased user expertise, and better CAI packages. Pressman and Rosenbloom (1984) noted that manufacturers have been assuming more of the training costs as competition has increased.

Respondents Comments

The expert panelists' responses were generally quite subjective. Most did not have detailed information on the actual costs of computer-assisted instruction. The following are notable responses:

> The Adult Learning Center is delivering CAI for approximately $2.25 per hour via the Local PLATO Delivery System (LPDS).
>
> Cost-effectiveness depends much on how fast hardware changes.
>
> CAI is very cost-effective once equipment is in place.
>
> CAI packages are extremely cost-effective. A $50 piece of software will replace several books, packs of paper, and tutor assistance. Over the one and a half years we have used these programs, they have been worth twice what we paid for them.
>
> They are very cost-effective. It cost $150,000 to start the computer center, including software and computers.

The initial start-up of a CAI laboratory is expensive. However, with extended use, the number of CAI packages make the program cost-efficient. This may not be realized until three or four years of laboratory operation.

Monetary issues play an important role in software selection.

We have made no study on this. However, so much enthusiasm and interest are evident among youth for computer instruction that the investment is always considered worthwhile.

Chapter 2

Criteria for the Evaluation of Computer-Assisted Instructional Packages

There are many variables that must be considered in the development of the evaluation designs to assess the effectiveness of CAI packages for the remediation of basic skills in JTPA programs. One of the most important sets of variables that needs to be considered in the evaluation concerns the CAI package itself. Other related variables to be considered in the evaluation design are the level of computer skill and training of the instructors implementing the CAI package and the instructors' level and quality of teaching skills. These variables will be discussed in detail in Chapter 3 on evaluation designs.

The evaluation design must include uniform and objective measures of what CAI means in operational terms as used in actual JTPA programs. These measures must account for the variance in the types of CAI packages available and used in JTPA programs and for variance in the quality of those CAI packages in terms of features required to meet the specific needs of the target JTPA population. There are many different kinds of CAI packages in current use in JTPA programs. The manner in which a given package is used varies from program to program, and the capabilities of the hardware on which a given package is used also varies.

The various CAI packages vary widely on curriculum and software design features and on implementation options available. The set of variables relating to the CAI packages used in the evaluation design should reflect the extent to which the packages include certain critical curriculum and software design features considered most important to the target population. These critical features are those that have been shown to be most important in the current research literature, in the findings of the site visits, in the recommendations of the expert panel members and service providers, and in the review and examination of various CAI packages provided to the design project by vendors.

Taxonomy of CAI Package Features

The taxonomy developed by this project is a system of classifying CAI packages based on the needs of the JTPA population and the degree of complexity and quality of the technology employed in the CAI packages used by JTPA programs in the remediation of basic skills. The taxonomy requires consideration of three categorical factors useful in describing CAI packages:

1.0 Types of CAI Packages

1.1 Purpose of the Package

1.2 Context Orientation of the Package

1.3 Instructional level(s) of the Materials

It also requires consideration of three major factors affecting quality of CAI packages intended to be used in JTPA programs:

2.0 Quality Measures

2.1 Curriculum Features

2.2 Software Design Features

2.3 Implementation Features

The taxonomy includes a description of various aspects of each of these six factors. The taxonomy reflects the concern of educators and trainers for giving increased attention to the curriculum and related learning activities provided through the CAI packages. The curriculum is a major factor in stimulating and guiding student learning. It is important, therefore, that CAI packages be evaluated not only on their technical merits in terms of software design and implementation options but also on their curriculum design.

Curriculum design refers to the way in which curriculum is conceptualized and its major components are arranged. These major components may be categorized as content, instructional methods, instructional materials, learner experiences, and learner activities. The conceptualization and arrangement of the curriculum provide the direction and guidance needed as the curriculum is implemented in a CAI package through the development of the software design. The curriculum design is the basic framework for planning the content of the CAI package.

Every curriculum design is characterized by a certain philosophy of learning, teaching, and instruction. The philosophical base in this instance is distinguished by its emphasis on meeting the specific needs of the JTPA learners. To be effective, CAI packages must be concerned with JTPA learner characteristics and learning styles and concerned with the characteristics, goals, and objectives of the JTPA programs.

The following sections discuss two groups of major factors included in the taxonomy: types of CAI packages and quality measures. Within each of these sections, three major factors are presented and discussed citing specific aspects of the factors that have been shown to be important in the literature and current research findings.

1.0 Types of CAI Packages

CAI packages used in JTPA programs for remediation of basic skills are used by individual learners in training programs that vary in terms of size and resources available. The objectives and modes of operation of the programs vary. The JTPA participants vary in age, experience, and motivation. A good CAI package design must take these various needs into consideration and address specific needs or groups of needs at a specific instructional level. The following factors should be considered in classifying CAI packages based on needs of the JTPA population. The rationale for each factor is noted and the key aspects of the factors are discussed or highlighted.

1.1 Purpose of the Package

A CAI package can be classified according to the purpose or function for which it was developed and intended to be used. The purposes are presented in the order of complexity required in the software package to accomplish the purpose. A package that is primarily intended for drill and practice is less complex than one that is capable of simulating the application of a concept in the context of the work place. CAI packages may be designed to address a single purpose, or they may consist of multiple components with different purposes for each component. In the case of packages with multiple components with different purposes, the individual components should be evaluated separately in the same manner as a single purpose package. The purpose of the CAI package can be:

- Drill and Practice Exercises
- Supplemental Instruction
- Primary Instruction
- Simulation and Application

Drill and Practice

These CAI packages are designed to be used by the learner for extended practice in developing skills, speed, or comprehension of previously presented concepts. These packages do not teach any new material. They are designed to help the learner to develop specific learned skills through guided repetition and experience using the concept.

Supplemental Instruction

These CAI packages are used by the learner as supplemental material to enhance and support instruction provided by a teacher. The intent is to provide the learner with additional individual instructional time in a self-paced environment. These packages perform the task of tutoring the learner on concepts that have already been presented by an instructor. These packages are not intended to be sufficient for direct primary instruction, but must contain explanatory material that the learner can review and study to strengthen the understanding and comprehension of previously presented concepts.

Primary Instruction

CAI packages which are designed to be used by a learner for direct primary instruction on specific concepts fill much of the role of an instructor. They teach basic information and knowledge about specific concepts. The package must be capable of being used alone by a learner for sufficient independent instruction on the concept. The package must be designed to introduce and teach the concepts without requiring other supporting instruction. The package must insure that the learner has mastered each critical step in learning the concept prior to progressing onto the next step in the process.

Simulation and Application

CAI packages which provide simulation and application of concepts in a work place setting require the learner to use higher level conceptual skills of application, analysis, synthesis, and evaluation in applying the learned concepts to solve work related problems. These packages must provide realistic work related situations with multiple possible options available for the learner to manipulate in applying the concept. The learner must receive feedback and information from the software in response to the learner's actions and decisions. The feedback should simulate normal behaviors and responses that would be expected in the work place.

1.2 Context Orientation of the Package

The curriculum content of CAI packages can be designed and presented to reflect various orientations and environments. The package can use the functional context of work (Sticht, 1987) for instruction or it can follow other orientations such as the general education and subject matter orientation commonly found in CAI packages designed primarily for use in public education. The context orientation determines the subject matter and the nature of examples and situations used in the lessons. Within any context, the package should teach the critical processes important to the remediation of basic skills. After learning a basic skill process within a context relevant to the learner, the learner should be able to perform that basic skill in a new context. In other words, the learning should transfer to the future contexts in which the learners may find themselves. The context orientations may be:

- Specific Functional Context of Work
- General Functional Context of Work
- Life Skills Orientation
- Child Orientation

Specific and General Functional Contexts of Work

Within the functional context of work, only the skills needed for the job and directly related to job training are taught. All instruction in basic skills are related directly to the work place and taught in the context of skills needed to perform job related tasks.

The functional context for work can be highly specific to a particular job — incorporating the technical terms and functions of a specific trade or position such as an electrician — or it can reflect more general work place functions common to larger categories of jobs such as construction trades. Many packages use the more general work place orientation with the intent of being applicable, and therefore marketable, to a wider group of training programs and clients. Of course, the use of specific functional contexts of work for instruction are the most desirable for training people for those specific trades. The general work place functional contexts are the next most desirable orientations for the curriculum materials. Both context orientations are considered applications of the concept of functional context of work.

Life Skills Context

Other context orientations of CAI packages have no obvious relation to the work place but may reflect a variety of life skills and social settings common to adults and youth in the curriculum materials. These packages are designed for and marketed to job training programs, public schools, vocational-technical schools, and adult education programs in which adults and youth are expected to participate. The social settings may include purchasing groceries, banking, paying bills, completing job applications, etc. The focus is on functional literacy, functional skills, and life skills in context of training a person to function successfully and independently in society as a whole. This context may include some general work related settings and situations but is not limited to the functional context of the work place.

Child Orientation

Some packages were designed for use with young children in teaching basic skills in elementary schools. The child orientation in these packages is intentional and obvious. Because of the child orientation, these packages may be completely inappropriate for use in job training programs with youth and adult participants. The orientation will interfere with the purpose of the package by offending the participant's sense of maturity and dignity and by presenting the instructional concepts in unnatural contexts.

1.3 Instructional Level(s) of the Materials

The curriculum of a CAI package targets a particular group of learners at a specific instructional level. The entire CAI package may be designed for students at a particular instructional level, or it may include several components that cover a range of instructional levels. The instructional level of the CAI package must approximate the educational achievement level of the learner in order for learning to occur. A CAI package with an instructional level that exceeds the ability of the learner will cause the learner extreme frustration and will impede learning and may result in damage to the learner's confidence and motivation to learn. A package that is below the learner's ability may provide a temporary sense of accomplishment and a review of previously gained skills, but it will soon become boring and tedious. An appropriate level should challenge the learner with new concepts and skills presented at a level that the learner fully comprehends and with tasks that the learner can perform successfully with moderate effort. These instructional levels are classified as:

- English as a Second Language (ESL)
- Basic Literacy
- Adult Basic Education (ABE)
- General Equivalency Diploma (GED)
- Advanced Skills

English as a Second Language

The instructional level of English as a second language CAI programs is difficult to classify since knowledge of the English language is not directly related to the learner's level of educational achievement. A limited English speaking learner may be at almost any educational level and need English language instruction. Within ESL instruction, the instructional levels are reflected with such terms as beginning, conversational, intermediate, and advanced language instruction. However, the ability of an ESL student to benefit from participation in the upper levels of ESL instruction will be limited by their general educational ability. The upper level ESL instruction typically expects the student to be literate in their native language and to transfer skills in reading and writing to English. ESL does not and should not include teaching the basic concepts and skills of reading. In current practice, ESL programs follow a transitional model which teaches beginning and conversational levels of English with limited text oriented materials and then transfers the students to "mainstream" instruction in English at the appropriate academic level.

Basic Literacy and Adult Basic Education

The lower levels of basic literacy (grades 0-4) and adult basic education (ABE) (grades 5-8) tend to follow the public school grade level structure, although the specific grade level reference is sometimes replaced with some other label for the levels. The basic reading concepts and skills including word attack, reading comprehension, vocabulary, language arts, and writing skills are taught in well defined sequence and increments. The basic mathematics concepts and skills are taught including units of measure, addition, subtraction, multiplication, and division with integers, positive and negative numbers, fractions, and decimals.

General Equivalency Diploma (GED)

The GED level CAI packages are comparable to high school level material. Reading skills and written composition skills are taught and developed including speed, comprehension, vocabulary, logic, and grammar. Mathematics concepts, computation, and problem solving are taught through the levels of basic algebra and geometry. Beyond the basic skill areas of concern to JTPA, some CAI packages specifically designed for GED preparation include the other general education areas included in the GED examination.

Advanced Skills

Skills beyond the high school instruction level are required by many positions. The instructional level is equivalent to college and vocational-technical level instruction in mathematics, English, and the arts and sciences. The training of displaced workers for new jobs in skilled and technical areas requires specialized CAI packages which exceed the high school level instruction in certain technical aspects of the training. Professional development programs also exceed the high school instructional level and may include highly sophisticated and specialized training and simulations.

2.0 Quality Measures

The quality measures of the features of a CAI package determine the extent to which the package is capable of meeting the needs of the JTPA population. A defined set of features has been determined to be important to JTPA students. These features are consistent with the principles of sound curriculum design, software design, and implementation options for CAI packages. A few of the aspects of these quality features are specific to JTPA students and are based on the learning styles most commonly found in the target population. CAI packages found to possess the desired features are expected to be most effective in meeting the remedial basic skill needs of the JTPA students.

2.1 Curriculum Design Features

The most important curriculum design features of CAI packages used in JTPA programs for the remediation of basic skills can be grouped under the categories of content, flexibility, feedback, and learning styles. The curriculum provided through the CAI packages vary in their assumptions regarding the nature of the educational program in which the package will be used. Many JTPA programs are characterized by short-term programs in which learners have considerable control over the progress of their learning.

On the contrary, some CAI package are based on the general public school educational model in which the program tends to be long-term and under the guidance of a teacher. The curriculum is sequential and comprehensive, and evaluation is accomplished by periodic testing. It is assumed that teachers are available to provide any needed additional help in understanding the concepts presented. Such packages do not contain the features shown to be important to successful CAI in the literature and research.

The CAI package curriculum must include a number of important features in order for the curriculum to be complete. The features under each category that are judged to indicate a high quality CAI package in terms of curriculum design are listed below.

Content

The material is competency based and teaches the competencies required for adequate levels of job performance in the functional context of work. The material is presented in an appropriate form to motivate the learner, develop confidence in the ability to learn, and enhance learning under the control of the individual learner.

- Lesson objectives are clearly defined
- Concepts are covered in depth adequate for the purpose of the package
- Content is consistent with the instructional level
- Curriculum is a mastery based approach to job related competencies

- Content includes testing to document mastery of competencies
- Concepts are reviewed and reinforced
- Vocabulary, concepts, and examples are relevant to learner
- Lessons are manageable in size
- Content is logical and well-organized
- Material reflects current knowledge
- Content is grammatically error free
- Content is factually correct
- Content provides clear and effective demonstrations and examples
- Format is challenging but not frustrating
- Content avoids ethnic, racial, or sexual discrimination and stereotyping

Flexibility

The learner and/or instructor may tailor the instruction to meet particular job related or perceived needs rather than following a sequential learning process through a prescribed curriculum sequence. Through the software design, the learner should be able to use menus to make decisions such as repeating a series of exercises, reviewing instruction, seeking help, checking mastery, or exiting the package.

The content of a special set of items should be modifiable so the instructor can add and change special items to address topics of local or temporary importance. The package should provide the framework needed for these items. The instructor will be expected to provide the text of the instruction, the text of questions or exercises, the response options, and the correct answer.

- Difficulty level may be adjusted by the instructor and/or learner
- Some items can be customized by the instructor.

Feedback

The learner expects immediate feedback on performance from the educational experience and may avoid periodic testing. The learner expects to be able to get additional help from within the learning materials to clarify learning without relying on others for explanations. After a wrong response is detected, the package should loop to a new presentation of the concept or a help screen that provides additional instructional information or clues, and then allows the learner to retry the item or a similar item. Multiple wrong responses should result in a demonstration or example of the correct response and return the learner to a point where the instructional routine can be repeated or the learner can exit the program.

- Immediate feedback to learner on performance
- Help routines are available for clues and examples
- Multilevel branching after wrong responses to help routines and options
- Tone of address is appropriate to learners
- Feedback is useful and supportive of learning

- Summary of learner performance is provided

Learning Styles

CAI packages must meet the diverse needs of JTPA participants by being sensitive to different learning styles. CAI packages should encompass the auditory, visual, and tactile/kinesthetic approaches to learning. The package should include materials that address all the approaches. The software should include clear instructions to the learner on how to use any other materials provided. The package should coordinate and integrate the use of the various materials with the content of the software.

- Content coordinates and integrates use of other materials in the package with the software
- Content includes visual reinforcement of learning.
- Content includes auditory reinforcement of learning.
- Content includes kinesthetic and tactile reinforcement of learning

2.2 Software Design Features

There are many aspects of software design that are important in the selection and evaluation of CAI packages. The software design delivers the curriculum content contained in the software to the learner. It determines the nature of the teaching — learning environment on the computer. Through the software design, the author of the software (the instructional designer) plans an interaction with the learner. The instructional designer can incorporate sight, sound, and touch in the design to stimulate the learner and attempt to elicit planned emotional and intellectual reactions. Of course, the personal characteristics and psychological variables of individual learners will affect the responses obtained from the stimulus. The common set of characteristics of the target group of learners must be carefully considered in designing the software to achieve the greatest likelihood of desired responses.

Software design involves a complex set of factors. Each factor contributes to the effectiveness of the overall design.

An effective software design will permit the curriculum content to be delivered in a manner most appropriate for the target group of learners. Appropriate software design will allow the learner to obtain the maximum learning benefits from the material being presented. The amount of effort required of the learner to interact with the software will be rewarded by a sense of satisfaction. The learner's interaction with the software will result in immediate delivery of desired, expected, and relevant information and response from the software. The concentration of the learner should be focused on the curriculum material and content and not on the process required to interact with the software. Interaction with the software needs to be as natural and intuitive as possible. Once a routine of interaction with the software is established, it is desirable to follow that routine consistently throughout the software package.

Poorly designed software will interfere with the learning process by frequently distracting the learner from the curriculum content and focusing attention on the process required to use the software. Poorly designed software can create frustration and can interfere with learning even when the curriculum content being presented in the software is well designed and otherwise effective.

The following factors are important considerations in software design. Each factor is described and discussed in terms of criteria that should be considered in the development of the software.

User Interface with Equipment

The manner in which the user physically interacts with the software is through the senses of sight, sound, and touch. There are several aspects in each of these modes that are important in software design.

Visual interaction is through a monitor. The primary variables that are important are:

- **Color:** selection and range of colors in the display is effective
- **Resolution:** images are clear and detailed
- **Recognition:** images are realistic and easily recognized
- **Complexity:** a reasonable number of images are displayed at one time
- **Image size:** physical size of images and characters is appropriate
- **Animation:** any movement of images supports learning
- **Attraction:** techniques to focus or sequence attention are effective
- **Speed:** time required to generate images is reasonable

Sound can be produced by software and reproduced by various types of speakers. Recorded sound can be digitized and stored on disks. Digitized sound produces a more natural and higher quality sound than that produced by software manipulation of the frequency and duration of electrical current. The problem is that digitized sound uses enormous amounts of computer storage space. Some software places digitized sound on compact disc read-only memory (CD ROM) which reproduces the human voice but can be written on only once at present. Mechanical access to data on the CD ROM is very slow resulting in tedious delays in the programs. The variables important to sound and touch are:

- **Sound Quality:** sound is realistic
- **Devices:** use of headsets and speakers are supported
- **Adjustment:** learner can adjust tone and volume of sound
- **Keyboard:** use of keyboard is commensurate with level of instruction
- **Mouse:** use of a mouse is supported for selection of menu options
- **Lightpen:** use of a lightpen is available as an alternative to a mouse

When images and sound are used together, the displayed image and the sound or voice presented to the learner should be coordinated and complementary. The learner will be distracted or confused if the image presented and sound heard are unrelated.

The transmission of responses from the learner to the software is typically through motions of the hand on some device designed to control a cursor on the screen. The general options available are keyboards or number pads, light pens, and a mouse or tracking ball device. A touchscreen is another option available for some hardware. The learner makes a menu choice by touching the screen. The location of the learner's finger on the surface of the monitor is detected by a pressure sensitive grid on the surface of the monitor or by interruption of an array of lights and light-sensors around the edge of the monitor.

Although computer keyboards retain much of the standardization of the typewriter keyboard, they generally add numerous other keys for cursor control, numeric input, and specialized functions. Keyboards, efficient time-saving devices to experienced users, can be complex and intimidating to initial users. However, some users report benefit from learning to use the keyboard while simultaneously remediating basic skills when the software is appropriately designed.

Verbal responses of the learner in the interaction with the software can be recorded and stored by various devices. The response can be digitized and stored on disk for later access and reproduction in high quality or it can be stored on magnetic tape using a tape recorder.

Current technology allows only limited use of verbal commands from the learner to control the software. At present, voice recognition has not been developed to the point where it is a reasonable option for controlling educational software.

Functional Design Components

The control of the flow of action and events in the software allows the learner or the instructor to tailor the lessons to the specific needs of the learner. Control allows the user to select from available options provided by the software and to exercise choice in the operation and the duration of various routines and lessons.

Menu Systems

There are a variety of systems used to provide the learner with choices for controlling the software. Choices can be provided in a menu displayed on the screen, accessed by a mouse, or as functions assigned to specific function or control keys or combinations of keystrokes which can be invoked with or without a menu display.

Menus may be displayed in the following manner:

- Full screen displays are used effectively to provide detailed instructions to the learner.

- A small permanent section, generally a bar at the top of the screen, can be accessed by a specific keystroke or by touching the bar with the cursor using a mouse. The small section typically contains titles of other menus. These menus are contained in a temporary dialogue box which expands down from the selected title either automatically when touched by the cursor or by "clicking" a mouse. The dialogue boxes contain menu options that the learner may select to control movement from option to option within the software. Options can activate a lesson, a help routine, or a check of mastery of a concept.

- Similar to a dialogue box, a "pop-up" box, may be activated by a specific keystroke sequence or a function key.

The "pop-up" box appears somewhere on the screen and overlays the normal display. The box may contain information such as a clue, a formula, a reference table, a vocabulary list, or additional instructions; or it may contain a utility such as an on-screen calculator for student use. The "pop-up" box differs from the dialogue box in that it provides additional information or a utility for student use rather than a menu of choices to change the flow of the lesson.

- Software can provide a means for the learner to turn menus that occupy a portion of the screen on or off as desired to allow the learner to select to have constant display of the menu of choices or select to have a less cluttered screen on which to work.

It is important that the learner be able to reach and activate any menu choice rapidly. Systems that require extended effort to cycle through long series of unwanted menus in search of a desired choice are frustrating and time-consuming to use. Software design should group related option sets in the same dialogue box and allow random access for selection and activation of choices within the box.

The software design must allow for smooth and rapid exit from one menu to another with minimum effort. Menus should provide a non-destructive means to cancel or abort the action selected to allow the learner to escape from an unintended choice.

Design Components

The design components are routines that are provided for use by the learner or the instructor supervising the use of the software. These components allow the software to be used more efficiently with particular learners. They provide a means of defining a set of options and choices that will adapt the software to the needs of the learner. These routines include:

- Diagnostic routines to assess the level of performance of the learner in terms of the lessons available in the CAI package either as part of the software or as other material provided in the package
- Unit planning assistance to suggest and develop relevant groups of lessons based on learner performance and diagnostic routines
- Flexible lesson sequencing to allow the definition of a selected series of activities and lessons tailored to the needs and interests of the learner
- Multi-level lessons sequences that provide relevant units of instruction for adults who are functioning at various instructional levels in different content areas.
- Flexibility to easily branch to more difficult or easy instructional levels within lessons when needed
- Random use of items from a pool of items at a given level of difficulty — designed for use in a particular lesson to allow repetition of the lesson with a new set and sequence of items

Interaction with User

The software design should develop and maintain a supportive and positive emotional climate in its interaction with the learner. The software should provide adequate hints and explanations to effectively communicate to the learner what is expected for satisfactory response. It should allow the learner to edit work and entries easily. The necessary edit procedure may vary from a simple change of a single entry on the screen to a full screen editing of text.

The software needs to provide immediate feedback to the learner on performance and allow missed items and concepts to be repeated until the learner has gained mastery.

The software should follow consistent routines of interaction with the learner so that the learner can anticipate the next event and concentrate on the subject matter rather than the process of interaction.

The software should provide quick responses to all entries by the learner. The learner should not be concerned with possible reasons for delays or blank screens. The learner should have the ability of halting a lesson and returning at a later time. The software should expect that learners will enter and exit the lesson sequence at varying points.

The ability of the learner to make choices and exercise a degree of control over the learning process is very important. The process encourages independent decision-making. It develops and encourages the learners to assume personal responsibility for learning. The learner needs to have control over the repetition of lessons and the pace of instruction. The learner and/or the instructor need to have control over jumps to more difficult or to easier materials and the introduction of new materials and concepts. The learner needs to be able to enter and exit programs freely and to return to any point in the sequence of lessons. Time available for computer-assisted instruction may vary greatly from day to day depending on many factors.

Management Services

Software design should provide the instructor with options for keeping records on the learners using the software. These records should include reports by individual learner and by groups or classes of learners. Instructors need to have records maintained that show which lessons they selected to be included in a learning unit (based on diagnostic information) for each student. The records should be available both as printed output and as screen display. The management services should include routines to track individual learners in terms of:

- Lessons included in learning units
- Lessons assigned
- Lessons completed
- Performance on individual lessons
- Summary performance on learning units
- Amount of time learners spend on lessons
- Number of times a learner attempts a lesson

2.3 Implementation Features

The implementation features of the CAI package is an important consideration. Implementation features include the way the CAI packages are installed, maintained, and operated on microcomputer hardware.

Installation

Installation of the CAI package on project hardware can be one of the most frustrating stages of using CAI packages. At this stage, the project staff may have little or no experience with the CAI package. The installation process can be complex involving several steps requiring decisions about monitor type and resolution; locations for storage of programs, lessons, and work files; printer and communications options; keyboard, mouse, and lightpen options; memory requirements and allocations; local area network and security requirements; and sound options. The process involves copying numerous files from the vendor's distribution disks to the disks in the project's computer. The copying can be accomplished by installation programs provided by the vendor or by detailed instructions to the person installing the CAI package. Improper installation can result in the CAI package not being used at all or the package being partially used with less than optimum expected performance.

CAI vendors generally assume that installation and maintenance of the CAI package will be accomplished by a project staff member who has a working knowledge of the computer hardware used at the project site. Although many vendors provide limited technical assistance via telephone to assist project staff members in the installation process, the written materials provided with the CAI package provide the main installation instructions. The quality of these written materials is very important to successful and correct installation of the CAI package.

The installation instructions should make no assumptions regarding the hardware. Each requirement should be clearly stated. All requirements and any required modifications to configuration and system files should be stated explicitly with detailed and complete examples provided.

Any hardware or operational limitations and known equipment conflicts of the package that would affect installation must be clearly explained. The software design should not make any unnecessary restrictions on installation. A common problem involves the vendor assuming that the software will always be installed in the simple pattern of program files being stored on Drive C: of a hard disk and work stored on floppy disks in Drive A:. If these assumptions are followed to the point that drive designations are included in the vendor provided installation programs, it may be impossible to install the CAI package on more complex storage schemes commonly in use.

Each step in the installation process must be clearly described in the written installation materials and operate error free. Examples should be provided for each command required to correctly install the software and the responses resulting from the commands. The written material should include illustrations of the screen when several options are presented, and each option should be discussed in the installation materials.

Speed of Operation

Speed of operation of the CAI package is an important factor. The package should operate smoothly without excessive delays for loading data, preparing graphic displays, or performing other routines. Speed is affected by:

- Program design

- Microprocessor
- Video display
- Data storage devices

The programming used in the CAI package affects the speed of operation. A quick response to any input by the learner should be expected. The software design controls the sequence of events. An immediate response to learner input can and should be built into the software design. The response may vary from an immediate execution of the response to an immediate change in the display that indicates to the learner that the input has been received and action is being taken. If a delay is expected, a message or icon should be displayed explaining what is happening.

The speed and power of the microprocessor will have a significant impact on overall operational speed. The larger the amounts of data that can be handled at one time by the microprocessor, the faster the operation. Thus, the 32-bit microprocessors are more powerful and operate much faster than the 16-bit and 8-bit microprocessors. Clock speed measured in megahertz (MHz) also affects speed directly. A 32-bit microprocessor operating at 25 MHz is 56 percent faster than a 32-bit microprocessor operating at 16 MHz. Some complex programs may require the use of more powerful and faster microprocessors for satisfactory speed of operation. Of course, the most powerful and fastest microprocessors are much more expensive than the common models. Most CAI packages should operate with acceptable speed on the less expensive machines.

The speed of the video display also affects overall operational speed. A graphics display using pixels to form letters, such as is used exclusively in the Macintosh, requires the transfer of enormous amounts of information from memory to the video screen each time the screen is rewritten which results in a significant time delay. A display based on text, such as is common in IBM compatible machines, is much faster but less dramatic. All graphic displays, IBM or Apple, require frequent transfers of large amounts of video data and, therefore, require powerful and fast microprocessors for reasonable speed of operation for the CAI package. The basic relationship is: the greater the resolution and complexity of the image being displayed, the greater the amount of data that must be transferred and displayed, and the greater the time required to perform the required tasks.

Speed of operation is greatly affected by data access time. Fast access to data on a hard disk is important. The mechanical speed of operation of hard disks vary considerably. The access time is measured in milliseconds (ms). Presently, fast IBM compatible hard disk drives access data at about 18 ms compared to the 65 ms access on hard disk drives commonly used in the past. Mechanical access to data on floppy disks is very slow compared to access on hard disks. Access to large amounts of data on compact disk read-only memory devices (CD ROM) also tends to be very slow.

Performance Options

Error free operation is expected of all software. User error handling and recovery from user error should be designed to avoid sudden exits from the program and provide simple and clear information to the user about the nature of the error and what was expected.

The software should allow the use of a variety of peripheral equipment including printers, monitors, and disk storage devices.

Printer options should be available to allow the software to function with a wide variety of commonly used printers. Installation of printer drivers should be flexible so printers can be changed easily.

Cursor control options should include the use of a mouse. Other options should be clearly specified and explained in the installation guide. Monitor options and drivers should be provided to accommodate all major types of monitors on which the software can be used. If color or high resolution monitors are required, the requirement should be clearly stated in all literature.

Disk storage options should include the expected use of a hard disk system. No assumptions about drive assignments should be made. Options for use of floppy drives should be available and anticipated for student work disks. Individualized student work disks should be an available option for storage of student progress and performance data.

Installation and use of the software on a local area network should be anticipated and accommodated. Software should be available in both network and stand-alone versions. The commonly used local area network (LAN) systems (such as Novell, 3COM, IBM Token Ring, TOPS, and AppleTalk) provide projects with a cost-effective means of managing the use of CAI packages on hard disk servers. Less expensive workstations can access the more powerful central servers. The multiuser, multiprocessor LAN's provide many additional features beyond those available on stand-alone microcomputers including security systems, shared hard disk storage, shared printers and print spooling capability, multiuser file and record locking capabilities, and overall system control and monitoring.

Maintenance and Technical Support

Maintenance and updates should be provided following a reasonable policy for registered users. Documentation for the normal operation of the CAI package must be carefully written, accurate, and comprehensive. The documentation should include examples for all command sequences required to operate the software. Toll free (800 number) telephone technical support should be available for registered users. The vendor should provide options for clients to attend periodic in-service training sessions conducted by the vendor or agents of the vendor for extended training and technical assistance.

Evaluation Form

An evaluation instrument has been designed to establish values for each of the factors in the taxonomy. The instrument will produce a standardized and objective means of categorizing CAI packages and producing standardized numeric measures of quality for each of the features considered important for effective use of CAI packages with the JTPA population. The evaluation instrument will be used as part of the evaluation designs by skilled and trained evaluators employed by the Contractor performing the evaluation to examine and rate various CAI packages used in JTPA programs.

The evaluation instrument will yield three categorical variables describing the CAI packages in terms of:

- Purpose of the Package
- Context Orientation of the Package
- Instructional Level(s) of the materials

And, the instrument will yield three numeric measures of quality, one each for:

- Curriculum Features
- Software Design Features
- Implementation Features.

These categorical variables and numeric scores will be used in the numeric analyses of data in the evaluation design.

This form is intended to be used by evaluators who have experience with concepts of curriculum design and software design. The evaluators will be trained to categorize the CAI packages according to type and to describe the functional aspects of the CAI packages in terms of hardware requirements and available options.

The evaluators will undergo training to standardize their understanding of the meaning and intent of each of the items on the evaluation form. They will be trained to apply the form to evaluate actual CAI packages to establish numeric measures of quality for the curriculum, software, and implementation features found in the CAI package being evaluated.

The taxonomy and the evaluation instrument will serve the important role in the evaluation designs of operationalizing, establishing values for, several of the important variables related to the various CAI packages actually used in JTPA programs. They also will provide a means of obtaining a uniform, objective rating for various CAI packages intended for use in JTPA programs that may have utility outside of the planned evaluation process.

Pilot Test of Evaluation Form

A site visit was made to a small software company near the Pennsylvania-Delaware border after the taxonomy and evaluation form had been revised with feedback from exert panelists, consultants, service providers, and JTPA site visits. This contact was made on the recommendation of an ALT consultant who acknowledges the owners as experts in the development of CAI packages and has installed the company's materials in ABE/JTPA programs statewide. The purpose of the visit was to pilot test the validity and utility of the evaluation form on software specifically designed for the remediation of basic skills in JTPA programs. The project staff was also interested in the development and utilization of CAI packages from the vantage point of business and industry.

The software developers at the BLS Tutor Systems site were highly knowledgeable about both curriculum content and software design. Its staff randomly selected a company-designed ABE CAI package for the pilot test. Each section and item of the evaluation form was analyzed for clarity and relevancy. Ambiguous statements were marked for modification. Items representing philosophical differences among and between software designers and educators, e.g., learner versus teacher control of content sequencing and difficulty level, were identified so that concomitant ramifications for the rating scale could be predicted.

Personnel of Bidwell Training Center, Inc., also assessed the utility of the form with CAI packages used in their Literacy and ABE programs. The final version was tested by project staff with the CAI packages provided by the participating vendors (Appendix). Notes maintained during the five-hour session with BLS personnel were used by the project staff to refine and improve the evaluation form's design and utility.

Rating Scale

The form will be used by the evaluators to assess a CAI package in relation to the quality criteria presented. Each CAI package will be rated in terms of the extent to which each of the items contained in the form was presented in the package being reviewed. For each item, the following scale is used:

NA Not Applicable to this CAI package (A category to be used in rare instances where an item is not an appropriate feature for the package.)

0 = Feature does not exist in the package

1 = Feature exists but is very poorly presented throughout

2 = Feature is presented but needs some improvement

3 = Feature is well presented

4 = Feature is presented exceptionally well throughout

Scoring Process

A scoring process described in this section will produce a numeric score for each of the three quality measures: Curriculum Design Features, Software Design Features, and Implementation Features. The steps in the process are listed below:

1. A trained evaluator will operate the CAI package according to the instructions provided with the package on the type of computer equipment on which it was intended to operate by the vendor.

2. The trained evaluator will score the CAI package on each item in the evaluation form using the scale described above. For each feature, the evaluator will place a check in the box under the rating score given to the feature.

3. The evaluator will count the number of checks given in each rating column for each of the three quality measures and will enter the total in the boxes provided in the Count row at the end of each quality measure section. The total number of NA (not applicable) ratings will also be entered in the appropriate box provided.

4. The evaluator will multiply the count by the rating value and enter the product in the boxes provided

in the Total Score row. The sum of the boxes in the Total Score row will be entered in the box labeled Sum in the Total Score row.

5. The number of NA items will be subtracted from the total items indicated in the Final Rating row to find the number of Valid Features. The Sum in the Total Score row is divided by the number of Valid Features to yield a numeric Rating for each of the three quality measures. This Rating is entered in the box provided. The Rating is on the same four-point scale used to rate each of the individual features as described above. The decimal place should be rounded to two places.

The rating for each of the three quality measures can be conceptualized as grades for the CAI packages using the common four-point grade scale: A = 4.00, B = 3.00, C = 2.00, D = 1.00, and F = 0.00.

The Ratings provide a numeric scores to represent the quality of the CAI package in the evaluation design. The three types of CAI package items will provide categorical measures to be used in the evaluation design.

Space is provided on the form for note codes. Note codes will be used by the trained evaluators to refer to standardized comments, limitations, explanations, and qualifications that provide additional information about the extent to which features are available and presented in the CAI packages.

The CAI Package Evaluation Form presented on the following pages is intended to be printed on a single page, front and back, with two folds so that there are three "pages" on each side of the form. The inside three pages will contain sections 1.0 and 2.0 (page 52 of this report), section 2.1 (page 53), and section 2.2 (page 54). The outside or back of the form will contain the cover page (page 51 of this report), section 2.2 Continued (page 55) and section 2.3 (page 56).

CAI Package Evaluation Form

Description of the CAI Package

Name:

Contents of Package:

Version:

Publisher:

Cost:

CAI Package Code No:

Date of Review:

Subject Code:

Hardware Used for Review

Hardware Requirements:

Reviewers:

Quality Ratings:

Curriculum Design Features: ______

Software Design Features: ________

Implementation Features: _________

Hardware Limitations:

CAI Package Evaluation Form

1.0 TYPES OF CAI PACKAGES

1.1 Purpose of the Package

drill and practice exercises	☐
supplemental instruction	☐
primary instruction	☐
simulation and application	☐

1.2 Context Orientation of the Package

specific functional context of work	☐
general context of work	☐
life skills orientation	☐
child orientation	☐

1.3 Instructional Level(s) of the Materials

English as a second language (ESL)	☐
basic literacy	☐
adult basic education (ABE)	☐
general equivalency diploma (GED)	☐
advanced skills	☐

Instructons for Types of CAI Packages

Please check ONE box that best describes the purpose of the package or the subject component of a multiple purpose package.

Please check ONE box that best describes the context orientation of the package or the subject component of a multiple purpose package.

Please check ALL relevant boxes that describe the instructional levels of the materials included in the package or the subject component of a multiple purpose package.

2.0 QUALITY MEASURES

Instructions for Quality Measures

This evaluation form is intended to be used by trained evaluators to assess a CAI package used in the remediation of basic skills in JTPA programs. The CAI packages are evaluated in relation to the quality criteria presented in the following section. Each CAI package will be rated in terms of the extent to which each of the items specified in this form are presented in the package being reviewed. For each item, the following scale is to be used:

NA Not Applicable to this CAI package
(A category to be used in rare instances
where an item is not an appropriate feature for the package.)

0 = Feature does not exist in the package
1 = Feature exists but is very poorly presented throughout
2 = Feature is presented but needs some improvement
3 = Feature is well presented
4 = Feature is presented exceptionally well throughout

Please check only ONE box for each item.

Follow the instructions at the end of each section to calculate the Quality Rating

CAI Package Evaluation Form

2.0 QUALITY MEASURES — Continued

2.1 Curriculum Design Features

Content	*NA*	*0*	*1*	*2*	*3*	*4*	*Note Code*
lesson objectives are clearly defined							
concepts are covered in depth adequate for the purpose of package							
content is consistent with the instructional level							
curriculum is a mastery based approach to job related competencies							
content includes testing to document mastery of competencies							
concepts are reviewed and reinforced							
vocabulary, concepts, and examples are relevant to learner							
lessons are manageable in size							
content is logical and well organized							
material reflects current knowledge							
content is grammatically error free							
content is factually correct							
format is challenging but not frustrating							
content avoids ethnic, racial, sexual discrimination and stereotyping							
Flexibility	***NA***	***0***	***1***	***2***	***3***	***4***	***Note Code***
difficulty level may be adjusted by learner and/or instructor							
contains special items that can be modified by the instructor							
Feedback	***NA***	***0***	***1***	***2***	***3***	***4***	***Note Code***
immediate feedback to learner on performance							
help routines are available for clues and examples							
multilevel branching after wrong response to help routines and options							
tone of address is appropriate to learners							
feedback is useful and supportive of learning							
summary of learner performance is provided							
Learning Styles	***NA***	***0***	***1***	***2***	***3***	***4***	***Note Code***
content coordinates and integrates other materials in the package							
content includes visual reinforcement of learning							
content includes auditory reinforcement of learning							
content includes kinesthetic and tactile reinforcement of learning							
Count Row (Count of checks for each column)							
Rating Values	NA	x0	x1	x2	x3	x4	Sum:
Total Score Row (Count x Rating Value)	NA	0					=

Rating Calculation: 26 features— number NA = number Valid Features =__________

Sum of Ratings divided by Valid Features = Quality Rating for 2.1 =__________

CAI Package Evaluation Form

2.0 Quality Measures — Continued

2.2 Software Design Features

User Interface With Equipment	*NA*	*0*	*1*	*2*	*3*	*4*	*Note Code*
color: selection and range of colors in the display is effective							
resolution: images are clear and detailed							
recognition: images are realistic and easily recognized							
complexity: a reasonable number of images are displayed at one time							
image size: physical size of images and characters is appropriate							
animation: any movement of images supports learning							
attraction: techniques to focus or sequence attention are effective							
speed: time required to generate images is reasonable							
sound quality: sound is realistic							
devices: use of headsets and speakers are supported							
adjustment: learner can adjust tone and volume of sound							
visual and auditory material are consistent and complementary							
keyboard: use of keyboard is commensurate with level of instruction							
mouse: use of a mouse is supported for selection of menu options							
light pen: use of a lightpen is available as an alternative to a mouse							
Functional Design Components							
Menu Systems:	*NA*	*0*	*1*	*2*	*3*	*4*	*Note Code*
full screen displays are used effectively							
dialogue boxes are used effectively							
pop-up boxes are used effectively							
menu displays can be toggled on and off by learner							
movement among menus is simple and efficient							
exit and escape routines are available at all points							
Design Components:	*NA*	*0*	*1*	*2*	*3*	*4*	*Note Code*
diagnostic and placement routines are available with package							
unit planning assistance is available based on diagnostic results							
flexible lesson sequencing is supported							
multi-level lesson sequences is supported							
branching to lessons at different level of difficulty is supported							
items are randomly selected for use in repeated lessons							
Interaction With User:	*NA*	*0*	*1*	*2*	*3*	*4*	*Note Code*
a supportive and positive emotional climate is maintained							
editing routines for learner correction of errors are simple and effective							
use of help screens and explanations is appropriate and effective							
use of on-screen directions is effective							

CAI Package Evaluation Form

2.0 Quality Measures — Continued

2.2 Software Design Features — Continued

Functional Design Components — Continued

Interaction With User — Continued:	*NA*	*0*	*1*	*2*	*3*	*4*	***Note Code***
use of recorded voice instruction is effective							
routines are consistent and predictable							
responses to all user entries are immediate							
Management Services:	*NA*	*0*	*1*	*2*	*3*	*4*	***Note Code***
lessons composing learning units are recorded and displayed/printed							
lessons assigned to individual learners are recorded/displayed/printed							
lessons completed by learners are recorded/displayed/printed							
learner performance on lessons is recorded/displayed/printed							
summary performance on learning units is recorded/displayed/printed							
pre-test performance is recorded/displayed/printed							
post-test performance is recorded/displayed/printed							
time learners spend on lessons is recorded/displayed/printed							
number of learner attempts per lesson is recorded/displayed/printed							
Count Row (Count of checks for each column)							
Rating Values	NA	x0	x1	x2	x3	x4	Sum:
Total Score Row (Count x Rating Value)	NA	0					=

Rating Calculation: 43 features — number NA = number Valid Features =__________

Sum of Ratings divided by Valid Features = Quality Rating for 2.2 =__________

CAI Package Evaluation Form

2.0 Quality Measures — Continued

2.3 Implementation Features

Installation	*NA*	*0*	*1*	*2*	*3*	*4*	*Note Code*
installation guide is comprehensive and clearly written with examples							
installation programs allow options for storage locations							
installation procedures are simple and error free							
minimum configuration requirements are clearly specified							
peripheral hardware options are clearly specified							
local area network options are available							
Speed Of Operation	*NA*	*0*	*1*	*2*	*3*	*4*	*Note Code*
speed of opeartion is acceptable on intended equipment							
video display speed is reasonable on intended equipment							
data access speed is reasonable on intended equipment							
any delay in operation is explained by a message or icon							
Performance Options	*NA*	*0*	*1*	*2*	*3*	*4*	*Note Code*
operation is error free							
user error handling and recovery is effective							
printer options are available and can be changed after installation							
common monitor options are supported							
common disk storage options are supported							
common cursor control options are supported							
individualized student work disks are supported							
multiuser options on local area network are supported							
reasonable number of learners are simultaneously suppported							
reasonable number of learner records are maintained							
Maintenance and Technical Support	*NA*	*0*	*1*	*2*	*3*	*4*	*Note Code*
documentation is comprehensive and clearly written with examples							
maintenance and update policy is reasonable							
toll free telephone technical support is available							
in-service training options are available							
documentation is comprehensive and clearly written with examples							
Count Row (Count of checks for each column)							
Rating Values	NA	x0	x1	x2	x3	x4	Sum:
Total Score Row (Count x Rating Value)	NA	0					=

Rating Calculation: 24 features — number NA = number Valid Features =__________

Sum of Ratings divided by Valid Features = Quality Rating for 2.3 =__________

CAI Package Evaluation Form

Description of the CAI Package

Name:

Version:

Publisher:

CAI Package Code No:

Subject Code:

Hardware Requirements:

Hardware Limitations:

Contents of Package:

Cost:

Date of Review:

Hardware Used for Review

Reviewers:

Quality Ratings:

Curriculum Design Features: ______

Software Design Features: ________

Implementation Features: _________

CAI Package Evaluation Form

1.0 TYPES OF CAI PACKAGES

1.1 Purpose of the Package

- drill and practice exercises ☐
- supplemental instruction ☐
- primary instruction ☐
- simulation and application ☐

1.2 Context Orientation of the Package

- specific functional context of work ☐
- general context of work ☐
- life skills orientation ☐
- child orientation ☐

1.3 Instructional Level(s) of the Materials

- English as a second language (ESL) ☐
- basic literacy ☐
- adult basic education (ABE) ☐
- general equivalency diploma (GED) ☐
- advanced skills ☐

Instructons for Types of CAI Packages

Please check ONE box that best describes the purpose of the package or the subject component of a multiple purpose package.

Please check ONE box that best describes the context orientation of the package or the subject component of a multiple purpose package.

Please check ALL relevant boxes that describe the instructional levels of the materials included in the package or the subject component of a multiple purpose package.

2.0 QUALITY MEASURES

Instructions for Quality Measures

This evaluation form is intended to be used by trained evaluators to assess a CAI package used in the remediation of basic skills in JTPA programs. The CAI packages are evaluated in relation to the quality criteria presented in the following section. Each CAI package will be rated in terms of the extent to which each of the items specified in this form are presented in the package being reviewed. For each item, the following scale is to be used:

NA **Not Applicable to this CAI package**
(A category to be used in rare instances
where an item is not an appropriate feature for the package.)

0 = **Feature does not exist in the package**
1 = **Feature exists but is very poorly presented throughout**
2 = **Feature is presented but needs some improvement**
3 = **Feature is well presented**
4 = **Feature is presented exceptionally well throughout**

Please check only ONE box for each item.

Follow the instructions at the end of each section to calculate the Quality Rating

CAI Package Evaluation Form

2.0 QUALITY MEASURES — Continued

2.1 Curriculum Design Features

Content	*NA*	*0*	*1*	*2*	*3*	*4*	*Note Code*
lesson objectives are clearly defined							
concepts are covered in depth adequate for the purpose of package							
content is consistent with the instructional level							
curriculum is a mastery based approach to job related competencies							
content includes testing to document mastery of competencies							
concepts are reviewed and reinforced							
vocabulary, concepts, and examples are relevant to learner							
lessons are manageable in size							
content is logical and well organized							
material reflects current knowledge							
content is grammatically error free							
content is factually correct							
format is challenging but not frustrating							
content avoids ethnic, racial, sexual discrimination and stereotyping							
Flexibility	*NA*	*0*	*1*	*2*	*3*	*4*	*Note Code*
difficulty level may be adjusted by learner and/or instructor							
contains special items that can be modified by the instructor							
Feedback	*NA*	*0*	*1*	*2*	*3*	*4*	*Note Code*
immediate feedback to learner on performance							
help routines are available for clues and examples							
multilevel branching after wrong response to help routines and options							
tone of address is appropriate to learners							
feedback is useful and supportive of learning							
summary of learner performance is provided							
Learning Styles	*NA*	*0*	*1*	*2*	*3*	*4*	*Note Code*
content coordinates and integrates other materials in the package							
content includes visual reinforcement of learning							
content includes auditory reinforcement of learning							
content includes kinesthetic and tactile reinforcement of learning							
Count Row (Count of checks for each column)							
Rating Values	NA	x0	x1	x2	x3	x4	Sum:
Total Score Row (Count x Rating Value)	NA	0					=

Rating Calculation: 26 features— number NA = number Valid Features =__________

Sum of Ratings divided by Valid Features = Quality Rating for 2.1 =__________

CAI Package Evaluation Form

2.0 Quality Measures — Continued

2.2 Software Design Features

User Interface With Equipment	*NA*	*0*	*1*	*2*	*3*	*4*	*Note Code*
color: selection and range of colors in the display is effective							
resolution: images are clear and detailed							
recognition: images are realistic and easily recognized							
complexity: a reasonable number of images are displayed at one time							
image size: physical size of images and characters is appropriate							
animation: any movement of images supports learning							
attraction: techniques to focus or sequence attention are effective							
speed: time required to generate images is reasonable							
sound quality: sound is realistic							
devices: use of headsets and speakers are supported							
adjustment: learner can adjust tone and volume of sound							
visual and auditory material are consistent and complementary							
keyboard: use of keyboard is commensurate with level of instruction							
mouse: use of a mouse is supported for selection of menu options							
light pen: use of a lightpen is available as an alternative to a mouse							
Functional Design Components							
Menu Systems:	***NA***	***0***	***1***	***2***	***3***	***4***	***Note Code***
full screen displays are used effectively							
dialogue boxes are used effectively							
pop-up boxes are used effectively							
menu displays can be toggled on and off by learner							
movement among menus is simple and efficient							
exit and escape routines are available at all points							
Design Components:	***NA***	***0***	***1***	***2***	***3***	***4***	***Note Code***
diagnostic and placement routines are available with package							
unit planning assistance is available based on diagnostic results							
flexible lesson sequencing is supported							
multi-level lesson sequences is supported							
branching to lessons at different level of difficulty is supported							
items are randomly selected for use in repeated lessons							
Interaction With User:	***NA***	***0***	***1***	***2***	***3***	***4***	***Note Code***
a supportive and positive emotional climate is maintained							
editing routines for learner correction of errors are simple and effective							
use of help screens and explanations is appropriate and effective							
use of on-screen directions is effective							

CAI Package Evaluation Form

2.0 Quality Measures — Continued

2.2 Software Design Features — Continued

Functional Design Components — Continued

Interaction With User — Continued:	*NA*	*0*	*1*	*2*	*3*	*4*	*Note Code*
use of recorded voice instruction is effective							
routines are consistent and predictable							
responses to all user entries are immediate							
Management Services:	*NA*	*0*	*1*	*2*	*3*	*4*	*Note Code*
lessons composing learning units are recorded and displayed/printed							
lessons assigned to individual learners are recorded/displayed/printed							
lessons completed by learners are recorded/displayed/printed							
learner performance on lessons is recorded/displayed/printed							
summary performance on learning units is recorded/displayed/printed							
pre-test performance is recorded/displayed/printed							
post-test performance is recorded/displayed/printed							
time learners spend on lessons is recorded/displayed/printed							
number of learner attempts per lesson is recorded/displayed/printed							
Count Row (Count of checks for each column)							
Rating Values	NA	x0	x1	x2	x3	x4	Sum:
Total Score Row (Count x Rating Value)	NA	0					=

Rating Calculation: 43 features — number NA = number Valid Features =__________

Sum of Ratings divided by Valid Features = Quality Rating for 2.2 =__________

CAI Package Evaluation Form

2.0 Quality Measures — Continued

2.3 Implementation Features

Installation	*NA*	*0*	*1*	*2*	*3*	*4*	*Note Code*
installation guide is comprehensive and clearly written with examples							
installation programs allow options for storage locations							
installation procedures are simple and error free							
minimum configuration requirements are clearly specified							
peripheral hardware options are clearly specified							
local area network options are available							

Speed Of Operation	*NA*	*0*	*1*	*2*	*3*	*4*	*Note Code*
speed of opeartion is acceptable on intended equipment							
video display speed is reasonable on intended equipment							
data access speed is reasonable on intended equipment							
any delay in operation is explained by a message or icon							

Performance Options	*NA*	*0*	*1*	*2*	*3*	*4*	*Note Code*
operation is error free							
user error handling and recovery is effective							
printer options are available and can be changed after installation							
common monitor options are supported							
common disk storage options are supported							
common cursor control options are supported							
individualized student work disks are supported							
multiuser options on local area network are supported							
reasonable number of learners are simultaneously suppported							
reasonable number of learner records are maintained							

Maintenance and Technical Support	*NA*	*0*	*1*	*2*	*3*	*4*	*Note Code*
documentation is comprehensive and clearly written with examples							
maintenance and update policy is reasonable							
toll free telephone technical support is available							
in-service training options are available							
documentation is comprehensive and clearly written with examples							
Count Row (Count of checks for each column)							
Rating Values	NA	x0	x1	x2	x3	x4	Sum:
Total Score Row (Count x Rating Value)	NA	0					=

Rating Calculation: 24 features — number NA = number Valid Features =__________

Sum of Ratings divided by Valid Features = Quality Rating for 2.3 =__________

Chapter 3

Evaluation Designs

Two alternative evaluation designs are presented in this chapter. These evaluation designs are based on the information presented and discussed in the previous chapters. The designs were developed with careful consideration of current technical and research knowledge about the use of computer-assisted instruction (CAI) for the remediation of basic skills in JTPA programs. In the development of the designs, the *Standards for Evaluations of Educational Programs, Projects, and Materials* (Joint Committee on Standards for Educational Evaluation, 1981) were carefully considered and applied to produce designs that meet the utility, feasibility, propriety, and accuracy standards established by the Joint Committee.

The National Commission for Employment Policy requested the development of a large-scale, longitudinal design equal to approximately six professional person years of effort and an alternative small-scale, survey type evaluation design. Both evaluation designs are structured to provide information about the effectiveness and efficiency of CAI packages used in the remediation of basic skills in JTPA programs. The small-scale design retains the major sampling and analytic aspects of the large-scale design. However, for data collection, the small-scale design uses survey methods over a period of one year to obtain data while the large-scale design uses on-site data collection, observations, and follow-up procedures over a two year time period. The large-scale design will be discussed in detail. The small-scale design will be described by indicating the specific design elements of the large-scale design that must be eliminated or altered to reduce the scale of evaluation project.

For the purposes of the designs, the definition of CAI packages includes the software and all related instructional materials provided with the CAI package. It also includes the use of common materials and resources such as paper, pencils, calculators, dictionaries, maps, etc., incorporated by reference and instruction for their use in the CAI package.

The term "traditional instruction" will be used in the designs to mean the various types of instruction (such as lectures, films, workbooks, and projects) provided in JTPA programs that are not related to the use of a CAI package for the remediation of basic skills. This familiar term is preferred over the term "non-CAI" because of syntax difficulties and awkwardness when the latter is used. Traditional instruction does not mean to imply any negative values or lack of innovative effort associated with traditional methods of instruction. It is simply used as a term to differentiate other instruction from CAI. The limited research conducted by this project suggested that the evaluation design must anticipate that both CAI and traditional instruction will be used concurrently in most JTPA programs.

Assumptions

Many aspects of the operation of JTPA programs in terms of (a) recruitment and selection of participants; (b) methods of selection, purchase, and use of CAI packages; (c) use of traditional instruction; (d) and hiring and training of instructional staff are beyond the control of the funding agencies. JTPA programs select and purchase CAI packages from a wide variety of vendors. Funding agencies do not control the selection and purchase process. Thus, the extant variety of CAI packages used in remediation of basic skills should be reflected in the evaluation.

Many local factors affect the manner in which a given local program actually operates. Thus, evaluation designs should adapt to the natural setting as much as possible and should avoid an unrealistic clinical or laboratory model.

The JTPA programs involved in the evaluation design will be actual on-going programs. The evaluation will interfere as little as possible with the normal operation of the programs. The evaluation should not cause substantial changes in the operation of existing programs. The manner in which existing programs incorporate CAI packages and traditional instruction in the remediation of basic skills should be left intact.

The evaluation designs must follow sound research methodology to allow the results to be as generalizable as possible to the JTPA program population. The purpose is to obtain and evaluate information about the differential effects of CAI and traditional instructional modes and their respective cost-effectiveness, rather than to evaluate the participating programs. Thus, it is important that the participating programs represent the population of programs as adequately as possible. The participants must be representative of the participants found in programs throughout the population of JTPA programs. The manner in which CAI packages are used in the design must be representative as possible of the actual and normal use of such packages in existing JTPA programs.

The evaluation designs involve a variety of methods to assess the relative effectiveness and efficiency of CAI packages for the remediation of basic skills in job training programs. The designs evaluate and contrast two instructional modes: computer-assisted instruction against traditional instruction, each in their natural program settings. The designs use existing program participants, instructors, teaching methods, curriculum materials, software, and equipment. The designs attempt to monitor and measure the differential effects of the instructional modes with as little intervention and disruption as possible. The program participants should not notice any difference in the services delivered during the evaluation from services delivered before and after the evaluation is completed. The program staff in participating programs will be required to maintain and periodically report specific information on student performance and class participation that may or may not be different from their normal record-keeping process.

Large-Scale Design

The primary question to be addressed by the evaluation designs is:

How does the effectiveness and efficiency of CAI packages compare with traditional instruction for the remediation of basic skills in JTPA programs?

The effectiveness of the instruction modes will be determined by observing performance of JTPA participants on standardized test of basic skills after competing a normal period of instruction in a JTPA program in one or both of the modes. The efficiency of the instruction modes will be determined by contrasting the cost of obtaining a unit of increase in performance on a standardized measure of basic skills for CAI and traditional instructional modes.

The evaluation will consider and address several specific issues related to the primary question. The issues relate to the extent to which various sets of variables contribute to explaining the variance in the performance outcomes in remediation of basic skills. The sets include variables relating to program type, participant characteristics, instructor characteristics, time spent per instructional mode, and the CAI package characteristics. These variables exist in both traditional and CAI classes. Since JTPA programs are known to vary with respect to these areas, it is necessary to include these variables and control for their effects on performance outcomes in the assessment of the differential effects of CAI and traditional instruction.

Other related issues include a comparison of the effects of CAI and traditional instruction on persistence or retention rates of participants in JTPA programs. CAI may influence persistence more or less than traditional instruction. Student satisfaction with instructional services may vary with CAI and traditional instruction. The opinions of the participants will be helpful in understanding how students relate to the two modes of instruction. Job placement rates for participants may be affected by the instructional mode. Experience with computers and software may be an advantage for JTPA participants seeking employment. The long-term effects of CAI need to be better understood. A follow-up job survey will determine the effects of the two instructional modes approximately one year after leaving JTPA training. The follow-up will attempt to determine the extent to which the computer skills and software experience were relevant to the work place.

Sample

In the legislatively defined process followed in funding JTPA programs, funds flow from the federal government to the States and then to Service Delivery Areas (SDAs) which fund local JTPA programs. Because of the nature of the funding process, the most accurate information about current JTPA programs resides at the local level. Thus, considerable effort will be required in developing an accurate list of current JTPA programs and information about their use of CAI packages in the remediation of basic skills. Major CAI package vendors are able to provide lists of JTPA programs that hold current licenses for use of their products. Some published lists of JTPA programs are available but are subject to becoming out of date rapidly and virtually useless. The appendix contains current JTPA programs located for purposes of this report.

Stratification

Two primary strata must be adequately reflected in the sample: (1) programs which use CAI packages in remediation of basic skills and (2) programs which use *only* traditional instructional methods. These strata are of primary interest. It can be expected that variances in variables of concern to the evaluation will differ between the strata.

Other sampling concerns within each of these primary strata are representation for region of the U.S., type of program, and type of CAI package used (drill, tutoring, primary instruction).

CAI Stratum

For the purpose of the evaluation designs, a JTPA program in the CAI stratum should have at least 6 months of experience with a CAI package to be considered eligible for participation as a site using CAI. This requirement will help to ensure that the local staff is beyond the initial training and implementation phase. It is expected that these programs will also use varying degrees of traditional instruction. In the CAI stratum, the CAI packages used in the remediation of basic skills will be the software selected, purchased, and in use by the local programs prior to the evaluation. A variety of CAI packages should be expected to be in use. More than one CAI package may be used in a single program with a single participant. The evaluators will use the software evaluation form developed in this project and discussed in Chapter 2 to score all of the CAI packages being used in the CAI group on both the curriculum design factors and software design factors. These scores will be used in the analysis as variables in explaining the effectiveness of the CAI packages. A procedure is provided to account for use of multiple packages with a single participant.

Traditional Instruction Stratum

A JTPA program in the traditional instruction group should not be using CAI at all. These programs should represent the traditional instructional methods as clearly as possible.

Random Sampling of JTPA Programs

A list of all known JTPA programs in each stratum should be developed. A random sampling procedure should be conducted within each strata to select JTPA programs for participation in the evaluation. The randomly selected JTPA programs must be contacted and considerable effort expended to secure their commitment to participate in the evaluation. The need to continue the random sampling procedure to replace programs which elect not to participate should be anticipated.

The programs selected in the CAI group should be interviewed for potential problems with their use of the CAI package that would jeopardize their full participation in the evaluation. These programs should be using CAI in their regular and normal operation and should be beyond the training, introductory, or transitional use of CAI. Programs with potential problems that would limit full participation or with abnormal CAI operational problems should be replaced. A record of the reasons any program was rejected from the sample should be kept and reported in the final report.

JTPA Program Sample Size

Both strata must be well represented in the sample. Because the focus is on comparisons of the strata in terms of performance in remediation of basic skills, near equal numbers of programs for each strata should be obtained. It is recommended that 100 programs be included in the total sample, with approximately 50 JTPA programs in each of the primary stratum.

Number of Participants in the Sample

A random sample of participants or students in the programs selected and agreeing to participate will determine which students participate in the evaluation. The eligible participants would be only those students receiving instruction by the program for the remediation of basic skills and whose performance or record can be tracked for at least one year. Students not receiving remediation services but involved in other aspects of the JTPA program would not be eligible participants.

A random sample of 20 participants from each program will provide approximately 1,000 cases for each stratum and a total of 2,000 cases for the evaluation. The 20 cases will not create an unreasonable record-keeping burden on the individual projects. Of course, the proportion of participants involved (and the probability of being randomly selected) will vary somewhat depending on the number of students in remediation of basic skills in a project. The potential individual selection bias involved due to differences in number of eligible students is outweighed by the concern for maintaining a reasonable record-keeping burden on the local programs. If more than 20 cases per site are requested, the additional record-keeping burden could result in a potential for inaccurate data.

In all programs, the selection of the 20 participants per program must be random except in small programs where all participants in the program must be included in order to met the quota. Particular participants must never be purposefully selected to participate or excluded from participation.

Method

The method planned for the evaluation is outlined below. There are five outcome measures which are analyzed in relation to the two instructional modes, CAI and traditional instruction. Control variables are used to neutralize the effect of various program, participant, and instructor variables known or expected to have significant effect on the outcome measures. In the following sections, the criterion and predictor variables will be presented and discussed. The data collection processes will be described. The use of data collection forms and survey instruments to collect information on the variables will be discussed.

The primary analytic framework will be a pre-test, treatment, post-test design. The data will be analyzed by hierarchical model multiple correlation regression analyses to control for multicollinearity among the variables. The techniques required to perform the analyses will be discussed in detail. The format of suggested tables and graphs will be presented to aid in the interpretation of the findings. The analysis plans for each criterion variable will be described.

Criterion Variables

A series of outcome measures will be used in the evaluation to measure performance outcomes that may be influenced by the type of instruction provided. These outcome measures are directly related to the objectives of the JTPA programs. The outcome measures represent the criterion variables that will be considered in the evaluation. Five criterion variables will be considered:

- Post-Test Score on the Test of Adult Basic Education (TABE)
- Persistence (Retention) Rate of Participants
- Student Satisfaction Rating of Instructional Services
- Job Placement Rate for Participants
- Follow-up Job Survey Results

Test of Adult Basic Education (TABE)

The Test of Adult Basic Education (TABE) is a standardized test used to measure participant performance in the basic skills. The test provides scores for reading, mathematics, and a total score. The test is used widely in JTPA training programs and adult education programs to assess performance in basic skills. The validity of the TABE has been well documented, and the results of the TABE correlate well with other measures of performance in basic skills. It has been used extensively in programs with relatively brief periods of instruction, a common practice in JTPA programs. A set of pre-test scores in reading, mathematics, and for the total test using the TABE will be required for all participants and used as control variables in the analyses. Post-test scores will be used as criterion variables.

Persistence Rate

The Persistence (or retention rate) of Participants is an indicator of the value that the students place on participating in the program relative to other alternatives and uses of their time and effort. Experience with computers and CAI software may be perceived to be more valuable to some students and result in higher persistence rates than traditional instruction. Students may (or may not) find the CAI more interesting and motivating than traditional instruction.

Student Satisfaction Rating

The Student Satisfaction Rating is an opinion expressed by the students regarding the instruction provided by the program. Students may have different levels of satisfaction with the CAI and traditional methods of instruction. The measure of satisfaction will be determined by a questionnaire or interview schedule. The primary issues addressed will be participant opinion regarding issues such as quality, pace, motivation, value, appropriateness, and relevance of the instruction provided through CAI and/or traditional instruction.

Job Placement Rate

Differences in job placement rate for participants may be related to the participants' experience using computers and CAI packages. Job placement rate may be related to the level of performance attained by traditional or CAI instruction.

Follow-Up Job Survey

Students in both instructional groups will be tracked for at least one year. A Follow-up Job Survey will be used to determine the influence of the instructional method on getting the job, keeping the job, performance on the job, and perceptions of value of instructional methods in helping them succeed after leaving the program.

Predictor Variables

The predictor variables will include sets of variables expected to be related to differences in the outcome measures: the characteristics of the program, participants, instructors, time spent in instruction, and CAI packages.

Program Variables

The program variable set controls for the effects of type of program (Block Grant, Summer Youth, etc.) and class size. Some of the variance in the outcome measures is expected to be explained by or associated with these variables.

Program Type Set (X1)

Program type set of variables refers to the various types of JTPA programs. These are categorical variables and are operationalized by using effects coding (Cohen & Cohen, 1975, p. 188) with the Title IV Federal Program used as the base from which to compare. The program types included in the analysis are given below with the variable name used in the equations:

Program Type	X1a	X1b	X1c
Title II-A	1	0	0
Title II-B	0	1	0
Title III	0	0	1
Title IV	-1	-1	-1

Class Size (X2)

The class size is the average number of students in JTPA basic skills classes involved in the evaluation. This variable helps to characterize the structure of the JTPA class in which the instruction is delivered. It is a numeric variable.

Participant Variables

The participant variable set allows the analysis to determine the effect of the characteristics of the students involved in the evaluation. Some of the variance in the outcome measures is expected to be explained by or associated with these variables.

Language Group (X3)

The language groups are English as a second language (ESL) and native English speaking students. This variable is a categorical variable that will allow the analysis to determine the effect of language groups on performance in basic skills using the two instructional methods. The variable is coded as follows using dummy coding:

Language Group	X3
ESL	1
Native English	0

Age (X4)

Age of the participant will be entered as a characteristic of the participant to determine the effect of age on performance in basic skills for each instructional mode. Age is a numeric variable.

Schooling (X5)

Schooling of the participant will be entered as a characteristic of the participant to determine the effect of number of years of formal education on performance in basic skills for each instructional mode. Schooling is a numeric variable representing the number of years of formal education. For example, a participant who completed the sixth grade and dropped out of school in the seventh grade would have six years of education. This variable does not attempt to include any measure of quality or effectiveness of the number of years of schooling. The pre-test TABE scores discussed below are used to measure and control for current academic ability.

Work Experience (X6)

Work experience of the participant will be entered as a characteristic of the participant to determine the effect of number of years work experience on performance in basic skills for each instructional mode. Work experience is a numeric variable representing the number of years of work experience.

TABE Pre-Test Scores (X7a and X7b)

The pre-test scores for reading (X7a) and mathematics (X7b) will be used to control for the effect of the participant's academic ability in basic skills at the beginning of the period of instruction in either modes. Using the pre-test scores as control variables avoids the serious problems associated with the use of gain scores (Cohen & Cohen, 1975, pp. 64 and 67-68). The scores are numeric values that can be considered analytically as a set or individually.

Instructor Variable Set

The instructor variable set controls for the effects of the skills, characteristics, and qualities of the instructor on the participants performance in basic skills. The research conducted in the design project found that the expert panel members and the service providers tend to perceive the instructor to be very important to the success of CAI. Some of the variance in the outcome measures is expected to be explained by or associated with the instructor variables.

TESA Score (X8)

Phi Delta Kappa, a professional education association, publishes an instrument and training program, Teacher Expectations and Student Achievement (TESA). The TESA score focuses on teacher behaviors and classroom skills that encourage effective teaching practices with students who are perceived to be low achievers. The TESA program has been widely used and nationally validated. The TESA interaction model has been shown to be particularly effective in improving the quality of teaching of low achieving students.

The complete TESA scoring system focuses on high and low achieving students and the differences in teacher behavior between these groups. It is too extensive for the needs of the current evaluation, although it would likely be of benefit to some instructors in JTPA programs. For the purposes of the evaluation, the TESA interaction model presented below is of particular importance because it establishes a set of instructor behaviors that can be observed and rated as detailed in the TESA instructions and manuals.

STRAND A: Response Opportunities

- **Equitable Distribution:** Distributes response opportunities equitably versus unreasonably prohibits student from responding
- **Individual Help:** Gives student individual assistance versus ignores a request or signal for individual help
- **Latency:** Allows time for responding versus terminates response opportunity if response is not immediate
- **Delving:** Delves, rephrases, gives clues versus does not delve after unsatisfactory response
- **High Level Questions:** Uses higher level questioning; calls for student opinion, explanation, evaluation versus teacher suggests degree of difficulty associated with question

STRAND B: Feedback

- **Affirm/Correct:** Affirms or corrects student's performance versus does not react or comment after student's response
- **Praise:** Praises student's learning performance versus criticizes; goes beyond simply correcting or negating
- **Reasons for Praise:** Gives reason for praising student's learning performance versus is sarcastic or gives insincere praise
- **Listening:** Listens attentatively to student versus is inattentive
- **Accepts Feelings:** Accepts and reflects student's feelings in non-evaluative manner versus discourages or disparages student's feelings

STRAND C: Personal Regard

- **Proximity:** Moves within arm's reach of student versus isolates student
- **Courtesy:** Expresses courtesy versus makes rude or insulting remarks to student
- **Personal Interest and Compliments:** Takes personal interest in student or gives compliment versus curtails or belittles student's personal statement
- **Touching:** Touches student in a friendly manner versus rejects student's attempt to touch; slaps, grabs, touches angrily
- **Desist:** Corrects student behavior in a calm, courteous manner versus teacher displays hostility, unreasonable anger

The 15 elements of the interaction model establish a set of teacher behaviors and skills that are considered important for quality instruction and a set of negative or opposite behaviors that should be avoided. Through a series of five 30 minute observations, the instructor can be scored with simple counts on all fifteen items in the three stands described above. The score measures the extent to which the teacher exhibits the positive and negative behaviors during instruction. The local numeric scores can be compared with regional and national level data maintained by Phi Delta Kappa. For the evaluation, the score would be used as a numeric measure of instructor quality for both CAI and traditional instruction.

Teaching Experience (X9)

Years of teaching experience will be entered as a characteristic of the instructor in order to determine the effect of number of years teaching experience on performance in basic skills for each instructional mode. Teaching experience is a numeric variable. Teaching experience was selected as a more relevant variable for this evaluation than formal education because of the differences in the instructional methods. CAI is a relatively new approach with very limited opportunity for relevant formal training in direct contrast to extensive opportunities for formal education in traditional instructional methods. Since most teachers are required to be certified and have completed very similar formal educations, regardless of the instructional mode, the formal education was considered of little importance in the present evaluation. However, teaching experience would be helpful to instructors using either mode of instruction. The amount of teaching experience instructors have can vary widely.

Time Variables

A critical set of variables concerns the amount of time that the participants spend in each instructional mode. Time is anticipated to have an important effect on performance for both CAI and traditional instruction. Time is an important element in determining the relative effectiveness of the two instructional modes.

Total Time in CAI (X10)

Total time in CAI represents the total time measured in hours that a participant is involved in receiving instruction, using computers, or using materials associated with a particular CAI package during the student's participation in the JTPA program. Separate time records will be kept for each CAI package the participant uses in the manner prescribed on the data collection form for calculation of quality interactions used in the regression analyses. Total time in CAI is a numeric measure that will be used in conjunction with CAI quality measures in determining the effect of CAI instruction on performance in basic skills.

Total Time in Traditional (X11)

Time in traditional instruction for participants in either the CAI stratum or the traditional stratum will be measured as hours of lecture and of individual, group, or class discussion, desk work, or activities that have no association with CAI.

Total Time

Total time is the computed sum of time in CAI and time in traditional. This variable can be computed for supplementary analysis of the overall impact of instructional time on performance in basic skills. Since it is a direct function of the two variables, it will not be used in the regression analyses.

CAI Package Variables

The CAI package variables will be obtained from the evaluators use of the CAI Package Evaluation Form presented in Chapter 2. Each CAI package used in the evaluation must be rated using the form by trained evaluators. The scores determined for a particular package will be used consistently throughout the evaluation and applied to each case in which a student uses that package in any JTPA program. The results of the assessments of the CAI packages will not be made known to the local programs until the completion of the evaluation. At present it is not known what relationship the rating will have with performance in basic skills. Implications that a particular CAI package is "high quality" and another is not could bias the evaluation and limit the number of CAI packages used in the evaluation.

CAI Package Codes

Each CAI package rated with the evaluation form will be given a code number by the evaluators for use on the data collection forms. The results of the quality assessment of the CAI packages will be kept confidential until after the evaluation is completed. The codes will be used by the evaluators to identify the packages with the rating scores at the time of analysis. The CAI package code is not an analytic variable but simply a means of identifying the packages. It will be used to identify specific packages in the descriptive analyses which sort on the most effective and efficient CAI packages for various groups of participants.

Subject Code

Each CAI package will be given a subject code that indicates the primary basic skills focus of the package in terms of reading and mathematics. This variable will not be an analytic variable but another means of classifying the packages.

CAI Type Variables
(X12a X12b X12c X13a X13b X13c)

The CAI type variables will be entered in the analyses using three set of analytic variables used to classify packages by their instructional purpose as described in detail in Chapter 2. The classification will be made by the trained evaluator and recorded on the CAI package evaluation form. An effects coding technique will be used to code the variables for the regression equations. The coding for the purpose of the package is presented below. The effects coding scheme contrast each group with the entire set of groups.

Purpose	X12a	X12b	X12c
Drill and Practice	1	0	0
Supplemental	0	1	0
Simulation	0	0	1
Primary Instruction	-1	-1	-1

The coding for the context orientation of the package is presented below.

Context	X13a	X13b	X13c
General Work	1	0	0
Life Skills	0	1	0
Child Orientation	0	0	1
Specific Work	-1	-1	-1

There may be more than a single instructional level in a package. The data will be included in the data collection process using the CAI package evaluation forms but will not be included in the regression analysis. These data can be used in descriptive analyses of the packages.

CAI Quality Variables (X14 X15 X16)

Three quality rating variables will be produced by assessing the CAI package using the CAI package evaluation form. The variables are a numeric measure of three aspects of quality of CAI packages. The three quality variables will be mean quality ratings for all CAI packages used by an individual participant. The time spent per CAI package will be multiplied by the quality rating to obtain quality points. Total quality points divided by total time in CAI yields a mean quality rating for the participant who uses more than one CAI package during the evaluation.

For each CAI package the following three sets of calculations are made:

1. Time in CAI package x Curriculum Design Rating = Curriculum Quality Points

   Total Curriculum Quality Points / Total Time in all CAI packages = Mean Rating for Curriculum Design Features

2. Time in CAI package x Software Design Rating = Software Quality Points

   Total Software Quality Points / Total Time in all CAI packages = Mean Rating for Software Design Features

3. Time in CAI package x Implementation Design Rating = Implementation Quality Points

   Total Implementation Quality Points / Total Time in all CAI packages = Mean Rating for Implementation Design Features

The mean quality ratings will provide

X14 Mean Rating for Curriculum Design Features

X15 Mean Rating for Software Design Features

X16 Mean Rating for Implementation Features

The CAI quality variables are of major importance in the evaluation and will be included in the equations as main effects and in interactions with time in CAI. These interactions represent the total quality points function and permit the analyses to consider the effect of a CAI package of a certain quality on performance at varying amounts of time.

Data Collection Methods

The evaluators will provide detailed instructions and forms to the participating projects to report data for each of the 20 randomly selected students participating in the evaluation. The data will be aggregated by the project and mailed to the evaluators.

The evaluators or trained special personnel will make site visits to program sites for monitoring the data collection process. They will spot check the record-keeping process and verify accuracy of the data. The programs will administer the required pretest and post-test using the TABE. The programs will administer the satisfaction survey instruments to their respective participants. Information on persistence and job placement will be maintained and provided by the programs on the evaluator forms. The programs will provide information about employment to the evaluators who will make the one-year follow-up contacts and administer the follow-up survey.

During the site visits, the evaluators or the trained special personnel will gather data for each of the predictor variables not included on the forms and additional qualitative information about the use of CAI packages for remediation of basic skills. They will observe the use of the CAI packages and interview students and staff involved in the use of CAI packages. They will observe the instructors in both CAI and traditional instruction modes and use the TESA instrument to obtain the instructor ratings. The evaluators will gather the necessary data for the cost variables for a cost-effectiveness analysis detailed below.

The trained evaluators will use the CAI evaluation form on site or in the evaluators office to assess the CAI packages used in the JTPA programs and obtain the CAI type information and the quality ratings. A given CAI package need only be assessed once. The ratings for a CAI package will be used consistently throughout the evaluation. The evaluators will determine a method of using consensus of a panel or a series of evaluators to assess the packages to obtain valid and reliable ratings for the packages.

Data Analyses

The statistical procedures planned to analyze the data are outlined below. The procedures will require the use of a mainframe computer and statistical packages such as the Statistical Package for Social Sciences (SPSS-X) or the Statistical Analysis System (SAS).

Multiple Regression Correlation Analyses

Hierarchical model correlation regression analyses will be used to analyze the reading and mathematics criterion variables in relation to the predictor variables described above. Four regression analyses are required. For the data from programs which use both CAI and tradition instruction, one regression analyses will analyze the data in relation to the reading criterion variable and another will analyze the data in relation to the mathematics criterion variable.

Another pair of regression analyses will be required for those programs having only traditional instruction. Of course, in these analyses, all variables relating to CAI will be deleted. Otherwise, the analyses will proceed in the same manner as described below.

A comparison of the results between the two pairs of analyses will provide more insight into the effects of CAI. The traditional only instruction group will provide a base line with which the CAI instruction can be compared.

There will be approximately 1,000 cases used in each of the two pairs of analyses. Therefore, the statistical power will be adequate to test the variety of predictor variables and interactions included in the equation.

Multicollinearity

The predictor variables are expected to be correlated to some degree due to the existing nature of the JTPA programs. This multicollinearity requires that a model be established that defines the order in which the variables are entered into the equations. The use of hierarchical model correlation regression analyses will permit each variable or set of variables to be tested for statistical significance in explaining incremental variance in the criterion variable as the set is entered into the equation (See Cohen & Cohen, 1975, for a thorough discussion of the rationale of this procedure).

Procedures

The data must be entered into data bases such that all variables can be accessed using the SAS or SPSS-X programs on a mainframe computer. The data should be carefully checked and verified for accuracy before the analysis is conducted. Missing data elements will mean that the case is excluded from the analyses. Efforts should be made to obtain complete data for all participants in the evaluation. Initial descriptive statistics should be obtained for each variable and carefully studied to detect outliers and possible data entry errors. Obvious data problems in cases should be reconciled and corrected or the case should be eliminated so that it does not distort the analyses.

Regression Equations

The variables used in the regression equations have been defined and discussed above. The following equations will be used in two regression analyses, one for reading and one for mathematics, using the same predictor variables.

Post-Test
TABE Score
=

a	Constant
	1. Program Set
+ X1a + X1b + X1c	Program Type Set
+ X2	Class Size Variable
	2. Participant Set
+ X3	Language Group
+ X4	Age of Participant
+X5	Years of Schooling
+ X6	Years of Work Experience
+ X7a + X7b	Reading, Math pre-test
	3. Instructor Set
+ X8	TESA Score
+ X9	Teaching Experience
	4. Instructional Set
+ X10	Total Time in CAI
+ X11	Total Time in Traditional
+ X12a + X12b + X12c	Purpose of CAI Package
+ X13a + X13b + X13c	Context Orientation
+ X14	Curriculum Design Rating
+ X15	Software Design Rating
+ X16	Implementation Rating
	Traditional Interactions
+X8 * X11	Time in Traditional * TESA Score
	CAI Quality Interactions
+X10 * X14	Time in CAI * Curriculum Rating
+X10 * X15	Time in CAI * Software Rating
+X10 * X16	Time in CAI *Implementation Rating
	CAI Type Interactions
+X10 * X12a +X10 * X12b +X10 * X12c	Time in CAI * Purpose Set
+X10 * X13a +X10 * X13b +X10 * X13c	Time in CAI * Context Orientation
	CAI Quality and TESA Interactions
+X8 * X14	TESA Score * Curriculum Rating
+X8 * X15	TESA Score * Software Rating
+X8 * X16	TESA Score * Implementation Rating

Testing the Main Effects

The main effects of the predictor variables will be tested by first running a protected F-test to determine if the overall equation explains a statistically significant amount of the variance in the criterion variables. The .01 level of statistical significance will be used. The test of the main effects will be performed by entering the predictor variables in sequence indicated by the equation variable number (X3 then X4). Variable sets such as X1a, X1b, and X1c will be entered at one step. At each step the added increment of variance in the criterion variable explained by or associated with the added predictor variable will be tested for significance using an appropriate F-test (Cohen & Cohen, 1975, p. 136).

The results will indicate the extent to which each variable is able to explain differences in basic skills performance beyond the differences accounted for by the variables already in the equation. This process controls for the effects of previously entered variables and removes the problem of multicollinearity from the interpretation of the results.

The interpretation of the categorical variables will be a contrast with the entire set of groups (Cohen & Cohen, 1975, p. 191). The raw regression coefficients indicate the effects of the groups.

Testing the Interactions

A series of interactions are tested next. An interaction of time in traditional instruction and TESA score is tested. If it is significant, the interaction should remain in the equation. It will indicate whether or not the effect of time in traditional instruction on basic skills performance is dependent upon various levels of the TESA measure of teacher quality.

The CAI quality interactions are tested next. There are three separate interactions to be tested in the sequence given. These interactions will determine if the effect of time in CAI on basic skills performance varies with various levels of CAI package quality in each of the three areas assessed. It is suggested that the measures be entered in the order given. An interaction is determined to be significant when the incremental variance is determined to be statistically significant. If the interaction is not significant, it may be dropped from the equation prior to testing the next interaction. All main effects involved in any interactions included in the equation must be retained and entered prior to the interaction.

Next, the interactions of time in CAI and purpose of the CAI package and the interaction of time in CAI and the context orientation of the CAI package are tested. These interactions will determine whether or not time and type of package interact in the effect on performance.

The last interaction test is the TESA Score and the CAI quality measures. These interactions determine if the teacher quality interacts with the CAI package quality in relation to the performance measures.

Interpretation of Results

The results of the regression analyses should be interpreted with care. The results of the regression analyses should be displayed in a table showing the variables entered at each step and the increment in R-squared, the squared multiple correlation coefficient, which indicates the added percentage of variance in performance explained by a variable or set of variables added at that step. For each increment, the degrees of freedom, F-test, and probability should be given.

The interactions must be tested prior to interpreting the main effects. A significant interaction means that the main effect involved in the interaction cannot be interpreted correctly in isolation from one another. Thus, the main effects are meaningless and the interpretation of the variables must be made through the interaction. Graphs should be used to illustrate the results of all interactions found to be significant. The production of the graphs requires that the regression equation be entered into a microcomputer spreadsheet program (such as Lotus 1-2-3). The equation is solved using means for all control variables and selected values for the main effects being studied. The process allows various situations to be entered and illustrated, given the effects of each variable as determined by the regression analysis.

Cost-Effectiveness Analysis

The cost variables collected using the CAI package evaluation form and on-site data collection activities will provide data that may be compared with the outcome performance measures. The cost elements important to the analysis are:

- **CAI Package Costs:** The cost of each CAI package used in the JTPA program. These are fixed direct costs.
- **Hardware Costs:** The cost of all computer hardware used in CAI in the JTPA program. These are fixed direct costs. There is little if any salvage value or trade-in value for used computer equipment because it becomes obsolete rapidly and the cost of comparable new equipment tends to be less than what was paid for the old equipment.
- **Maintenance Costs:** The cost of maintaining the hardware and the CAI package used in the JTPA program. These are variable direct costs that may increase as a function of hours of use and the age of the hardware.
- **Training Costs:** The cost of training instructors to use the CAI package are variable direct costs depending upon the turnover of personnel.
- **Instructor Costs:** The personnel cost for instructor(s) are variable costs that are a function of hours of use. These costs should include salary or wages and associated fringe benefits.

The fixed costs can be spread over the total hours of use during the expected life of the CAI package and hardware for an estimated cost per hour of using the CAI package. The more the package and computer system are used, the more benefit is received from the investment. However, the recurring costs increase with use as a function of hours of use of the CAI package and hardware. A comparison of the cost per unit of output in terms of basic skills performance for CAI versus traditional instruction will provide an analysis of the cost-effectiveness of the CAI and traditional instruction modes.

Cost-efficiency can also be considered. The cost per hour of operation may be calculated for the CAI package using these cost elements. The productivity of the CAI package per hour will be determined by the regression analyses, controlling for various conditions and variables in the JTPA program. The productivity is measured in increases in performance in standardized measures of basic skills using the TABE. Thus, the cost-efficiency of the CAI package can be determined per productivity unit per hour.

$$\frac{\text{CAI Package Cost} + \text{Hardware Cost} - \text{Salvage Value}}{\text{Life-Time Hours}} = \text{One-Time Cost per Hour of-Use}$$

+ Estimated Hourly Training Cost
+ Estimated Hourly Maintenance Costs
+ Hourly Instructor Cost

Total Hourly Cost of CAI

$$\text{Cost-efficiency} = \frac{\text{Productivity per Hour}}{\text{Total Hourly Cost of CAI}}$$

A similar analysis of the cost of traditional instruction can be compared to the cost-efficiency of the CAI package. In the traditional instruction mode, the computer related costs will not be considered, of course, but the costs of other instructional materials such as books and supplies must replace them. Equipment used in the traditional instruction should also be considered in the same manner as the computer equipment has been considered in the above structure. The regression equation using the traditional only instruction group will provide the productivity measures for use in this cost-efficiency analysis.

Survey Analysis

The results of the surveys should be used to make comparison of overall instructional group effects on persistence and placement rates. A t-test should be conducted to determine the statistical significance of the difference between mean persistence rate and mean placement rate for Traditional Instructional Group participants and CAI Group participants.

A comparison should be made of the results on items on the Satisfaction Survey and the Follow-up Job Survey Results for two instructional groups. Where applicable, the results need to be presented in tables and graphs. Numeric data should be tested for statistical significance with t-test or analysis of variance.

Descriptive Statistics

Descriptive statistics on the variables collected throughout the evaluation should be performed and reported in tabular form. These data will be important in describing the sample and the nature of CAI and traditional instruction in JTPA programs.

Qualitative Analysis

The evaluation should include a qualitative or case study approach that collects adequate descriptive data to permit a valid narrative portrayal of the use of CAI and traditional instruction in JTPA programs. This analysis should include a careful description of the way in which CAI is implemented and used in JTPA programs. It should address the problems and success that various programs have experienced in using CAI instruction. The qualitative study should consider how the use of CAI and traditional instruction are combined in those programs that use both modes. Consideration should be given to determining why some programs use CAI and why others do not. The level of training and experience of the local staff and their attitudes toward CAI are important issues to be addressed.

Small-Scale Design

The small-scale evaluation design follows the same basic structure as the large-scale design in terms of issues to be addressed, variables of importance, and analytic design. However, to reduce the scope of the evaluation, some of the elements must be altered or dropped from the design.

Data Collection Process

The data collection processes to be eliminated are:

- The process describing the follow-up of participants in the JTPA project will be dropped entirely.
- The observation of teachers using the TESA instrument will be dropped entirely.
- The qualitative data collection process that requires on-site interviews and observations will be dropped for the small-scale design.
- On-site monitoring and spot checking the data collection process will not be possible in the small-scale design.

The data collection process will rely on program cooperation and accuracy. The instructions provided with the forms must be carefully written and pilot tested. Communication with the programs through the mail and telephone will help the process, but some problems should be expected.

The evaluator in the small-scale evaluation will use the CAI evaluation form provided in Chapter 2 to assess the CAI packages in the same manner described in the large-scale evaluation. However, depending upon resources and time available, the number of packages may be restricted. A wide representation of CAI packages will be important. The use of one of the selected CAI packages could be a requirement for eligibility to participate in the small-scale evaluation. This will limit the population of JTPA program that will be included in the sampling process.

Sample Size

The sample size will be cut in half for the small-scale evaluation. This will permit more time to be spent in obtaining valid data from a smaller sample of programs. The use of external personnel will be limited. The required computer resources will be less, but SPSS-X or SAS on a mainframe will still be required.

Data Analysis

The small-scale evaluation will require the same high level of statistical and research skills required in the large-scale project. But, it will involve less travel and on-site participation in the data collection process. The level of effort required to conduct the analysis and report the finding will be approximately the same. The number of cases involved will have little effect on the statistical work.

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Appendix

Vendors Providing CAI Materials for Preview

Panel of Experts

Technology Consultants

List of JTPA Programs Interviewed

List of 70001 and Affiliates/CAI Programs

Comprehensive Competencies Programs (CCP) with JTPA Funding

Vendors Providing CAI Materials for Preview

Apple Computer
20525 Mariani Avenue
Cupertino, CA 95014
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Francesca Venning-Townsley, Contact

BLS Tutor Systems
5153 W. Woodmill, Suite 18
Wilmington, DE 19808
800-545-7766
Albert Siegfried, Contact

Conover Company
P.O. Box 155
Omro, WI 54963
414-685-5707
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Control Data
6003 Executive Blvd.
Rockville, MD 20852
301-468-8694
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EDL
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HEC Software
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